

Division of Aquatic and Wildlife Resources

Guam Department of Agriculture



Annual Report Fiscal Year 1999

ANNUAL REPORT FISCAL YEAR 1999

DIVISION OF AQUATIC AND WILDLIFE RESOURCES

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PERIOD COVERED:

October 1, 1998 to September 30, 1999

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY '99

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May 2000
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ACKNOWLEDGEMENTS

The Division of Aquatic and Wildlife Resources, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

Fishermen who cooperated with fishery data collection;

Individuals who reported poaching and illegal fishing activities, and wildlife sightings;

Public agencies and private citizens who helped in the marine preserve program;

Buyers who participated in the commercial fishing receipt book program;

Landowners who provided access to freshwater survey sites;

The Marine Lab, University of Guam;

Dr. Lynn Raulerson and Dr. Greg Witteman of the University of Guam;

Natural resources staff at Andersen Air Force Base and COMNAVMAR;

Biological staff from the Guam National Wildlife Refuge; the U.S. Fish and Wildlife Service, Ecological Services office in Honolulu; the U.S. Geological Survey, Biological Resources Division; the U.S. Department of Agriculture, Wildlife Services; and the U.S. Army Corps of Engineers;

Biological staff from the Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands;

Dave Hamm and his staff at the National Marine Fisheries Service;

Personnel from the Division of Law Enforcement, U.S. Fish and Wildlife Service;

Print and electronic media for coverage of Division programs and activities and for their support of conservation education programs.

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JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-3C-7
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs (1630, 2630)

PERIOD COVERED: October 1, 1998 to September 30, 1999

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration and endangered species programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division minimal staff changes during the year. All reported actions occurred between October 1, 1998 and September 30, 1999. There were two personnel actions involving: resignation (1) and deceased (1) during FY99.

Wildlife: The brown tree snake program Biologist I, Alan Searle, resigned in January.

Law Enforcement: Officer Domingo Pangelinan passed away in February.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY98 under its various federal programs and submitted them to the US Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY98. This documentation included annual Grant Agreements for 1) Project FW-3C, Guam Fish and Wildlife Coordination, which covers the administration and coordination of the Division's Federal Aid programs and which is jointly funded by wildlife (PR) and sport fisheries (DJ) funds; 2) Project F-1R, Guam Sport Fish Investigations, which covers sport fish research and survey activity and which is funded with sport fisheries (DJ) funding; and 3) Project W-1R, Guam Wildlife Investigations, which covers wildlife research and survey activity and which is funded with wildlife (PR) funds. In addition, annual Grant Agreements and

Amendments were prepared for the Division's various Fisheries Development and Endangered Species Investigations (Section 6) projects.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

The Division's administration and coordination responsibilities are 50% funded by local funds.

The Chief served on the Area Committee for Oil Spill Response. In addition, he is a member of the Criminal Justice Advisory Committee at Guam Community College.

The Chief continued to serve as a member of the Technical Advisory Committee for the I Tano'ta land use plan being developed by the Territorial Planning Council. He also served as a member of the Technical Review Committee (now Rehabilitation Advisory Board [RAB]) for the Andersen Air Force Base Institution Restoration Program (IRP) as well as for Naval installations other than Naval Air Station.

The Division participated in a series of meetings with the Department of Parks and Recreation, the Chamorro Land Trust Board, and the Bureau of Planning to review the inventory of Government of Guam lands to determine which have the best potential for incorporation into the Territorial Park System as Conservation Areas in accordance with the mandate of PL 22-18, which requires that the two Departments (Agriculture and Parks) develop a comprehensive master plan before any additional lands are so designated. A draft plan was completed and being reviewed at the end of the report period.

Fisheries and Wildlife Supervisors serve as members of the Area Committee's Oiled Planning and Operations Subcommittees.

Division staff made a number of off-island trips related to Federal Aid and other programs:

Tino Aquon and Kelly Brock, Wildlife Biologists, represented the Division at the meeting of the National Research Council's Committee on the Scientific bases for Preservation of the Mariana Crow in Honolulu in April.

Kelly Brock, Tino Aguon; Andrew Torres and Todd Pitlik, Fisheries Biologists, attended the Federal Aid Basic Grants Management class in Honolulu.

Gary Wiles, Wildlife Biologist, attended a Bat Conference in Colorado in November.

Bob Anderson, DAWR Chief, attended the Brown Tree Snake Symposium in Honolulu.

Kelly Brock also observed the captive breeding program of an endangered rail species in New Zealand, which is very similar to Guam's captive breeding program. In addition, she attended the Non-Federal Lands Negotiation Conference in Tennessee last September.

Numerous trips were made to Rota in support of the Guam Rail and Marianas Crow projects. The following personnel with the number of trips included: Agriculture Director Frank San Nicolas (1), DAWR Chief Robert Anderson (1), Wildlife Supervisor Robert Beck (1), Wildlife Biologists Kelly Brock (2), Grant Beauperes (2), Tino Aguon (2), Lamont Henderson (1), Diane Vice (1), and Wildlife Technician II Robert Cruz (1)

Veronica Cummings, Fisheries Biologist, attended the Clean Vessel Act Coordinators meeting in February

Trips funded by the Western Pacific Regional Fisheries Management Council included the following trips to Honolulu, HI: Fisheries Biologists Andrew Torres, Tom Flores, and Todd Pitlik attended the Bottomfish, Pelagic, and Coral Reef Ecosystem Plan Team meetings respectively in FY99.

The Division hosted a number of off-island visitors during the year.

PROGRAM COST

The estimated cost of the Coordination/Administration project is \$75,000.

This report was prepared by: Gerald W. Davis

JOB PROGRESS REPORT INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-3C-7
SUB-PROJECT NO.: C-3
JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife
Restoration and Endangered Species Programs (2520, 2530, 1630)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

The Natural Resource Information and Education Officer position approved by the Governor and the Civil Service Commission during FY97 remained unfilled in FY99.

One fishing derby was held in FY99, which was a one-day event at Sirena Beach, AAFB. To date, five marine derbies have been co-sponsored by DAWR and AAFB.

The Division continues to distribute posters, flyers, pamphlets, coloring books and videos to the public and schools. The Division also continues to make classroom presentations at the island schools.

The Division continued to issue press releases on its projects and activities, set up static public displays, conduct press conferences, submit feature articles to the print media, make radio and television appearances, and respond to requests for information from students and members of the general public.

BACKGROUND

The Public Awareness and Conservation Education Program (PACE) was established in support of the Division's mission to protect, preserve, develop and enhance Guam's aquatic and wildlife resources. The program consists of school presentations dealing with aquatic and wildlife conservation, kids' fishing derbies, news releases, static public displays, public service announcements, press conferences, and feature articles the production of resource materials for classroom use including coloring books, activity guides, posters, and informational flyers.

Up until FY90, the program was facilitated primarily by a Public Information Officer (PIO), and periodically by biologist staff. During FY90, Conservation Officers (COs) began providing direct support to the PACE effort by conducting classroom visits. The PIO position was vacated in late FY96 and since then the classroom visitation portion of the program has been supported by Conservation, Fisheries, and Wildlife staff.

The effectiveness of the PACE programs and activities can best be measured by the community's continuing response in reporting suspected poachers and poaching activities to COs and police, the growing interest and demand for resource conservation materials, and the increase in teacher and student requests for fish and wildlife presentations. As in the past, residents continue to report bird sightings, bring in injured birds or birds

presumed to be endangered species, and generally to encourage the institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

Activities and efforts during FY99 included the following:

1. Presentations on endangered species, coral reef ecology (esp. toxic marine sea creatures) and fish and wildlife conservation in general, were delivered public and private elementary schools, middle schools, and high schools, university classes, and groups such as the 4-H Club, Cub Scouts, and Department of Parks and Recreation Summer Camp. These presentations were usually accompanied by a live Guam rail, fruit bat, brown tree snake, monitor lizard, or various marine organisms, as appropriate. Numbers of presentations were given in FY99 in the following: Conservation = 15 school presentations; Fisheries = 32 school presentations; and Wildlife = 33 school presentations, 6 hunter safety briefings (Anderson Airforce Base), and 2 slide shows (UOG). In addition, the Fisheries and Wildlife sections accommodated a film crew from France to tape a television segment on the effects of the brown tree snake on Guam.
2. The Division continues to distribute color posters on the reef and pelagic fishes of Guam to public upon request at the Division office and to replenish the posters previously supplied to every school classroom on Guam. The Sport Fish Restoration Program funded the development and production of the posters.
3. The Division continues to distribute color posters on the Dangerous and Poisonous Sea Creatures to the public upon request. The Guam Coastal Zone Management Program funded the production of the posters, while DAWR provided some of the photographs and technical support.
4. The Division continues to distribute color flyers of Guam's animal, plant and marine life to the schools and public upon request. The PACE program funded the development and production of the flyers and the Coastal Zone Management Program funded the printing.
5. The Division continues to distribute Mariana fruit bat (*Pteropus mariannus*) posters to the public upon request and replenish the posters previously supplied to every school classroom. The development and production of the posters were funded by the Wildlife Restoration Program; printing funds originated from the Bureau of Planning's Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration.
6. The Division distributed all remaining copies of a coral reef ecology video (30-min) intended for use in public fisheries presentations and for distribution to schools, public libraries, museums, and other educational institutions. In addition, free copies of the video were available to the public upon request. The Sport Fish Restoration Program funded the production and supplies of the video.
7. Displays on the brown tree snake, Guam rail, and various other fish and wildlife conservation programs, were set up during Earth Week, the University of Guam Charter Day, and other similar events.
8. Division programs and activities continue to gain extensive media coverage. Newspaper and television feature articles on Guam rail, Micronesian kingfisher and

Mariana crow recovery efforts are periodically done, as are hunting and fishing activities and enforcement. In addition, a number of off-island media visited Guam during the year to film and document brown tree snake impact on Guam's natural resources and efforts to control its spread to other islands.

9. The Division participated in Youth Leadership Day activities and hosted one University of Guam special projects student as an intern.
10. Division staff developed press releases and feature articles and participated in media conferences on various conservation topics.

RECOMMENDATIONS

1. Fill vacant Natural Resource Information and Education Officer position as soon as possible in FY00.
2. Develop and implement a Hunter Education program to complement the existing PACE program utilizing Division biologists, COs, and community volunteers as instructors.
3. Develop and implement specific public education programs on the brown tree snake and the recovery programs for the Mariana crow, the Micronesian kingfisher, the Guam rail, and other endangered indigenous species. Incorporate the importance of cultural pride and concern for the recovery of indigenous wildlife in the presentations.
4. Develop a teacher-training program for aquatic education.
5. Continue to hold freshwater and marine fishing derbies and clinics for children. In addition, develop a new series of freshwater and marine fishing derbies, clinics, and other events for older youths, ages 13 through 17, and for adults.
6. Explore the possibilities of corporate sponsorship for specific endangered species recovery, conservation, and public awareness programs.
7. Continue aquatic and wildlife presentations at public and private schools, libraries, summer camps, after-school programs, and civic organizations.
8. Develop and implement workshops on various natural resource conservation topics for public and private school teachers.
9. Continue public awareness program through press releases, news articles, press conferences and other media to keep the public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs.
10. Update existing and develop new public service announcements for television and radio.
11. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, Guam Coastal Management Program, Sea Grant, the University of Guam Extension Service, Department of Parks and Recreation, the Guam Environmental Protection Agency, the U. S. Fish and Wildlife Service, the U. S. National Park Service, and the Guam National Wildlife Refuge.

12. Develop a traveling exhibit program to present information on the Division's fish and wildlife, conservation and management programs, and natural resource conservation educational materials in village community centers.

PROGRAM COST

The estimated cost of the PACE project is \$20,000.

This report was prepared by: Todd Pitlik and Diane Vice.

JOB PROJECT REPORT **RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO: F-1R-7
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 1

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys

JOB 1: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin, Agat Marina, and the Merizo boat-ramp facility from October 1998 through September 1999. The FY99 islandwide offshore catch (see Table 1), from primarily small recreational-type vessels, is estimated to be 549.9 metric tons (m.t.). The bulk of the catch, 329.7 m.t., was landed by the trolling method, consists primarily of five pelagic species. Bottomfishing produced an estimated 63.2 m.t., both snorkel spearfishing and SCUBA spearfishing produced a total of 61.4 m.t., while night-light jigging produced an estimated 21.6 m.t. Other methods such as surround net, gillnet, castnet, jigging, spincasting, and other methods encountered during offshore surveys account for 74.0 m.t. Compared with FY98, the total FY99 offshore catch increased slightly, 4%. Comparing only the trolling, bottomfishing, spearfishing, and night light jigging activity, total offshore catch decreased slightly, 6%. Trolling and nightlight jigging showed decreases in catch compared with FY98, 13% and 31% respectively, while bottomfishing and spearfishing catches increased 57% and 11% respectively. The offshore catch from other methods more than doubled compared with FY98, due primarily to boat-based gillnet and surround net catches of bigeye scad (*Selar crumenophthalmus*) that were encountered during offshore creel surveys.

TABLE 1: Composition of the Guam Offshore catch during FY99. Weights are in metric tons (m.t.).

Offshore Fishing Method	FY99 Catch
Trolling	329.7
Bottomfishing	63.2
Spearfishing	61.4
Atulai night-light jigging	21.6
Other Methods	74.0
Total FY97 Offshore Catch	549.9

BACKGROUND

Effective management of the island's offshore fishery resources requires the collection and analysis of data on fishing effort, methods used, and harvest. In order to identify trends in fishing participation, effort, and catch, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the

past 22 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff, as well as changes in the fishery. Since FY97, the National Marine Fisheries Service (NMFS) and DAWR have been developing and are completing a computerized database program to collect, input, and analyze the offshore fisheries data. The expansion program's algorithms are currently being reviewed, verified, and improved and should be completed this next fiscal year. The data in the FY99 report should still be considered preliminary data. During FY99, historical offshore data since 1984 was entered into the new database system. The statistical basis for the expansion can be found in NOAA SWFC Admin. Reports H-83-21C and H-92-08.

OBJECTIVES

1. To quantify fishing participation, effort, and catch of fishing methods which generally occurs outside the reef margin and are boat-based.
2. To collect biological data from the specimens examined during interviews.
3. To continue and complete the review and verification of the Guam Offshore Expansion System.

PROCEDURES

Interviews of returning fishing parties utilizing the three major boat ramps on island were conducted four days each month at the Agana Boat Basin (two weekends and two weekdays), two days each month at the Agat Marina (one weekend and one weekday), and two days each month at the Merizo boat ramp facility (one weekend and one weekday). Each of these days were randomly selected within weekdays (WD) and weekend/holiday days (WE/H) fields. Agana Boat Basin surveys consist of two periods, from 0500 to 1200 hours and from 1600 to 2400. The Agat Marina and Merizo boat ramp facility survey times differ slightly in the morning survey hours, 0530 to 1200 and 0600 to 1100 hours respectively. During FY99, the Merizo boat ramp facility was undergoing construction, and was unavailable from January 1999 until May 1999. Surveys at the Agat Marina were doubled during this period. Islandwide offshore participation was determined by means of a morning and evening survey, two weekdays and two weekends a month, of all public boat launching areas and accessible makeshift launching sites where trailers attached to vehicles were counted, but no interviews were taken. The expansion program assumes that a percentage of boats operating out of the Agana Boat Basin, Agat Marina, and the Merizo boat ramp facility that are fishing is proportional to the types of fishing occurring around the island as a whole.

Important changes in the data expansion process were incorporated into the offshore survey since FY97. These changes include using quarterly rather than monthly expansions in order to account for seasonal fisheries, using the boat log data to calculate participation in the expansion process, expanding data from the three surveyed ports rather than just the Agana Boat Basin, separating charter and non-charter fishing activity, and separating bottomfishing into shallow and deepwater strata.

All complete interviews had catch, participation, and effort data collected for each method encountered. For most interviews, the catch was identified to the species level. However, if a species breakdown is not possible due to time constraints imposed by the fishermen, a total weight, either estimated or actual, is recorded.

RESULTS

Trolling

Five major pelagic species account for 90% of the total troll catch by weight (Table 2). Yellowfin tuna (*Thunnus albacares*) made up 25% of the troll catch, followed by mahimahi (*Coryphaena hippurus*, 24%), bonita (*Katsuwonus pelamis*, 16%), wahoo (*Acanthocybium solandri*, 13%), and Pacific blue marlin (*Makaira mazara*, 12%). The remainder of the troll catch was composed of rainbow runner (*Elagatis bipinnulatus*, 4%), kawakawa (*Euthynnus affinis*, <2%), great barracuda (*Sphyræna barracuda*, <2%), and other species.

TABLE 2: Composition of the Guam troll catch during FY99 by most common species. Weights are in kilograms.

Troll Species	Total Catch	% of Troll Catch
<i>Thunnus albacares</i>	83,387	25
<i>Coryphaena hippurus</i>	79,260	24
<i>Katsuwonus pelamis</i>	52,015	16
<i>Acanthocybium solandri</i>	42,091	13
<i>Makaira mazara</i>	40,397	12
<i>Elagatis bipinnulatus</i>	11,952	4
"Assorted Troll Catch"	5,919	<2
<i>Euthynnus affinis</i>	4,829	<2
<i>Sphyræna barracuda</i>	4,465	<2
<i>Gymnosarda unicolor</i>	2,493	<1
<i>Carcharhinidae</i>	1,454	<1
<i>Istiophorus platypterus</i>	1,049	<1
Other species	437	<1
Total	329,748	100

Comparing trolling participation between FY99 and FY98, the number of trolling trips increased 15%, 15,883 trips up from 13,836 trips, while the number of people trolling increased 8%, 49,747 people compared with 46,296 in FY98. Weekdays had an average of 9.47 trolling trips per day, while weekends and holidays averaged 22.76 trips a day for an overall average of 16.11 troll trips per day. Approximately 49% of all boats interviewed on offshore surveys were trolling trips, 15,888 out of 32,505 offshore trips. Non-charter boats made up 81% of the trolling trips, with each trolling trip averaging 3.8 hours with an average of 4.2 fishermen. Comparing between ports, 46% of all trolling trips originated from the Agana Boat Basin.

Comparing effort, the number of hours spent trolling increased slightly in FY99 (6%), 60,958 hours compared with 57,716 hours in FY98. There were 234,717 gear hours and 18,105 person hours of trolling effort during FY99. Troll catch decreased 13%, 329.7 m.t. down from 377.7 m.t. in FY98. Landings increased 90% for Pacific blue marlin (40.4 m.t. compared with 21.3 m.t.) and increased 19% for yellowfin tuna (83.4 m.t. compared with 69.9 m.t.), while decreased 43% for wahoo (42.1 m.t. down from 73.9 m.t.), decreased 40% for bonita (52.0 m.t. down from 86.7 m.t.), and decreased 27% for mahimahi (79.3 m.t. down from 108.8 m.t.). Yellowfin tuna replaced mahimahi as the top pelagic species caught in FY99.

Trolling catch rates decreased from the harvests in FY98. Catch per hour fished decreased 17%, 5.41 kg/hr compared with 6.54 kg/hr in FY98, while catch per gear hour decreased 14%, 1.40 kg/gr-hr compared with 1.63 kg/gr-hr in FY98. Charter boat activity made up a significant portion of the trolling activity on Guam. Charter boats made up approximately 5% of the trolling fleet, yet account for 11% of the troll catch, 15% of trolling hours, 19% of all trolling trips, and 36% of people trolling in FY99. Charter boats account for 25% of the total blue marlin catch and 20% of mahimahi caught. During FY99, however, charter boats experienced a decrease in total catch, CPUE, and participation. Troll trips decreased 15%, 3068 trips down from 3,625 trips in FY98, while total charter troll catch decreased 34%, 36.9 m.t. down from 56.1 m.t. Charter boat catch per hour fished decreased 20%, 3.93 kg/hr down from 4.91 kg/hr in FY98, while catch per gear hour also decreased 16%, 1.52 kg/gr-hr down from 1.80 kg/gr-hr.

Bottomfishing

An estimated 63.2 m.t. of bottomfish were landed during FY99, a increase of 57% from FY98. The bottomfish catch (Table 3) was dominated by four major families: Lutjanidae or snappers (16.4 m.t., 26% of the total bottomfish catch), *Lethrinidae* or emperors (13.0 m.t., 21), *Serranidae* or groupers (5.8 m.t., 9%), and *Carangidae* or trevallys and jacks (4.1 m.t., 6%). Compared with FY98, *Lethrinidae* catches increased 80%, *Lutjanidae* catches increased 106%, *Carangidae* catches increased 8%, and *Serranidae* catches decreased 19%.

TABLE 3: Composition of the Guam bottomfish catch during FY99 by Family* and most common species. Estimated weights are in kilograms.

Family/Species	Total Catch	% Total Catch
<i>Lutjanidae</i>	16,411	30
<i>E. coruscans</i>	6,742	41+
<i>L. kasmira</i>	2,926	18+
<i>P. auricilla</i>	1,874	11+
<i>A. rutilans</i>	1,198	7+
<i>A. virescens</i>	933	6+
<i>P. zonatus</i>	889	5+
<i>Lethrinidae</i>	13,061	21
<i>L. rubrioperculatus</i>	5,079	39+
<i>L. harak</i>	2,114	16+
<i>L. xanthurus</i>	1,839	14+
<i>L. obsoletus</i>	1,615	12+
<i>L. olivaceus</i>	745	6+
<i>Serranidae</i>	5,800	9
<i>E. fasciatus</i>	3,636	63+
<i>C. igarashiensis</i>	619	11+
<i>Carangidae</i> *	4,135	7
<i>Seriola dumerili</i>	1,286	31+
<i>C. sexfasciatus</i>	787	19+
<i>C. lugubris</i>	725	18+
<i>Holocentridae</i>	2,640	4
<i>Balistidae</i>	2,469	4
<i>Mullidae</i>	2,197	3
"Assorted bottomfish"***	13,795	22
Total	63,154	

*over 1000 kg. +% in respective Family **unable to obtain species breakdown

The dominant bottomfish species caught during FY99 were onaga (*Etelis coruscans*, 6.7 m.t.), the redgill emperor (*Lethrinus rubrioperculatus*, 5.1 m.t.), the black-tipped grouper (*Epinephelus fasciatus*, 3.6 m.t.), the bluelined snapper (*Lutjanus kasmira*, 2.9 m.t.), the blackspot emperor (*L. harak*, 2.1 m.t.), the yellowtail kalikali (*Pristipomoides auricilla*, 1.9 m.t.), and the yellowlip emperor (*Lethrinus xanthochilus*, 1.8 m.t.), the yellowstripe emperor (*Lethrinus obsoletus*, 1.6 m.t.), the greater amberjack, (*Seriola dumerili*, 1.3 m.t.), and the silvermouth or lehi (*Aphareus rutilans*, 1.2 m.t.). The greatest increases were observed with onaga (6.7 m.t. from 19 kg), the yellowlip emperor (1.8 m.t. from 0.2 m.t.), the greater amberjack (1.3 m.t. from 0.3 m.t.), the blackspot emperor (2.1 m.t. from 0.7 m.t.), the bluelined snapper (2.9 m.t. from 1.3 m.t.), and the redgill emperor (5.1 m.t. from 2.1 m.t.). Decreases were observed with the honeycomb grouper (*Epinephelus merra*, 0.3 m.t. from 1.5 m.t.), the bigeye emperor (*Monotaxis grandoculus*, 0.3 m.t. from 1.4 m.t.), opakapaka (*Pristipomoides flavipinnis*, 0.3 m.t. from 1.0 m.t.), and the yellow spotted trevally (*Carangoides orthogrammus*, 0.4 m.t. from 1.1 m.t.). Other important bottomfish families encountered during FY99 include soldierfishes and squirrelfishes (*Holocentridae*, 2.6 m.t.), triggerfishes (*Balistidae*, 2.5 m.t.), goatfishes (*Mullidae*, 2.2 m.t.), tunas and mackerels (*Scombridae*, 0.7 m.t.), barracudas (*Sphyracnidae*, 0.5 m.t.), and wrasses, (*Labridae*, 0.4 m.t.). For 22% of the bottomfish catch, a species breakdown was not obtained due to time constraints imposed by the fishermen. Bottomfish trips that were interviewed were partitioned between shallow water and deepwater trips.

Comparing bottomfish participation with FY98, the number of bottomfish trips increased 18%, 10,365 trips up from 8,810. Approximately 83% of these trips were from non-charter boats. The number of persons participating in bottomfishing increased 38%, 49,747 compared with 36,263 in FY98, approximately 57% from non-charter fishing trips. There was an average of 4.89 trips on weekdays and 9.57 on weekends and holidays, with an overall average of 7.23 bottomfish trips per day. Bottomfish trips made up 32% total offshore trips, each trip averaging 4.0 hours and having 5.4 fishermen.

Comparing FY99 bottomfish effort with FY98, the number of boat hours increased slightly, 5%, 41,547 boating hours up from 39,538 hours. Approximately 90% of this effort were from non-charter boats. There were 145,812 bottomfish person-hours and 147,144 bottomfish gear-hours during FY99. Overall bottomfishing catch rates increased, compared with FY98. Catch per gear hour increased 34%, 0.43 kg/gr-hr compared with 0.32 kg/gr-hr in FY98.

Charter bottomfishing trips showed an overall increase in participation, effort, and CPUE compared with FY98. The number of charter bottomfish trips increased 8%, total catch increased 26%, 4.8 m.t. compared with 3.8 m.t., and the number of gear hours increased 7%, 36,518 compared with 34,230. CPUE increased 18%, 0.13 kg/gr-hr compared with 0.11 kg/gr-hr. The low CPUE value probably reflects the charter bottomfishing activity at the Agat Marina, which accounts for 80% of the total charter bottomfishing activity on Guam. The two main bottomfishing charter boats at Agat have up to three trips daily, fish in the same general area, and have up to 25 gear units per trip. These boats catch primarily goatfish and triggerfish which are generally released. However, they usually do not release large fish, and keep a part of the catch for sashimi.

Similar increases were observed with non-charter bottomfishing trips. The number of non-charter bottomfish trips increased 20%, 8,586 trips in FY99 compared with 7,168 trips in FY98, catch increased 57% 63.2 m.t. compared with 403 m.t. In FY98, and the number of gear hours increased 16%, 147,144 gear hours compared with 126,790 gear hours in FY98. CPUE increased 34%, 0.43 kg/gr-hr compared with 0.32 kg/gr-hr in FY98.

Deep water species comprised 23% of the total bottomfish catch (Table 4). Deep bottomfish more than tripled, 14.4 m.t. compared with 4.6 m.t. in FY98. Deep bottomfish was dominated with onaga (6.7 m.t.), yellowtail kalikali (*P. auricilla*, 1.9 m.t.), silvermouth or lehi (*Aphareus rutilans*, 1.2 m.t.), the greater amberjack (*S. dumerili*, 1.3 m.t.), gindai (*P. zonatus*, 0.9 m.t.). Approximately 0.9 m.t. of deep bottomfish was not identified to the species level due to time constraints imposed by the fishermen.

TABLE 4: Composition of the Guam deep bottomfish catch during FY99. Estimated weights are in kilograms.

Species	Total Catch (kg)	% Total Deep Bottomfish Catch
<i>Etelis coruscans</i>	6,742	30.8
<i>Pristipomoides auricilla</i>	1,874	21.0
<i>Seriola dumerili</i>	1,286	13.2
<i>Aphareus rutilans</i>	1,198	8.3
<i>P. zonatus</i>	889	6.2
Misc. deep bottomfish*	867	6.0
<i>Cephalopholis igarashiensis</i>	619	4.3
<i>P. flavipinnis</i>	324	2.3
<i>P. filamentosus</i>	289	2.0
<i>E. carbunculus</i>	224	1.6
<i>P. argyrogrammicus</i>	67	<1
Total	14,379	100.0

*unable to obtain species breakdown

Atulai Night-Light Jigging

Atulai night-light jigging trips were encountered year round during FY99. This method experienced the most significant decrease in participation and catch compared with other offshore survey methods. An estimated 21.6 m.t. of fish were landed, a 31% decrease from the 31.3 m.t. landed in FY98 (Table 5). Atulai comprised 90% of the night-jigging catch, a 15% increase from FY98. The remainder of the night-jigging catch consisted of dogtooth tuna (*Gymnosarda unicolor*, 0.8 m.t.), the white-margined lyretail grouper (*V. albimarginata*, 0.6 m.t.), *Carangidae* species (0.2 m.t.), *Sphyraenidae* species (0.2 m.t.), and a species of *Dasyatididae* (0.2 m.t.).

TABLE 5: Composition of the Guam atulai or bigeye scad (*Selar crumenophthalmus*) night jigging catch during FY99. Weights are in metric tons.

Species	Total Catch (kg)
<i>Selar crumenophthalmus</i>	19.5
<i>Gymnosarda unicolor</i>	0.8
<i>Variola albimarginata</i>	0.6
<i>Carangidae</i>	0.2
<i>Sphyraenidae</i>	0.2
<i>Dasyatididae</i>	0.2
Other	0.1
Total Catch (kg)	21.6

The number of atulai trips decreased 45% in FY99, 917 trips compared with 1,655 trips in FY98. Effort comprised of 5,258 fishing hours, 12,575 person hours, and 14,674 gear

hours. The number of gear hours decreased 61% compared with FY98, 14,674 gear hours compared with 37,976 in FY98. CPUE, however, increased. Catch per gear hour increased 52%, 1.47 kg/gr-hr compared with 0.82 kg/gr-hr, since the number of gear hours decreased proportionally more than the overall catch. Atulai night-jigging had an average of 0.97 trips per day, 0.87 on the weekdays and 1.06 trips on weekends and holidays. Each trip had an average of 2.2 fishermen fishing an average of 6.1 hours. Average catch rates were 1.5 kg/gear-hr and 4.1 kg/hr.

Spearfishing

An estimated 61.4 m.t. of speared fish, crustaceans, and mollusks were landed during FY99 (Table 6), an increase of 11% from FY98. The finfish catch (Table 7) was dominated by surgeonfishes (*Acanthuridae*, 17.8 m.t.), parrotfishes (*Scaridae*, 11.5 m.t.), groupers (*Serranidae*, 2.8 m.t.), emperors (*Lethrinidae*, 1.8 m.t.), and mullets (*Mullidae*, 1.4 m.t.). The bluespine unicornfish (*Naso unicornis*) was the most important spearfish species taken, comprising 61% of the *Acanthuridae* catch and 19% of the total spearfish catch, followed by the Pacific longnose parrotfish (*Hipposcarus longiceps*, 2.7 m.t.), the yellowband parrotfish (*S. schlegeli*, 1.9 m.t.), and the bullethead parrotfish (*S. sordidus*, 1.4 m.t.). Marine invertebrates, *Trochus niloticus* (1.3 m.t.) and the spiny lobster (*Panilurus penicillatus*, 1.2 m.t.), followed in overall catch. For 19% of the spearfish catches, a species breakdown was not possible due to time constraints imposed by fishermen. For these interviews, an estimated catch weight, as well as participation and effort data, were taken.

TABLE 6: Composition of the Guam spearfish catch during FY99. Weights are in kilograms.

Family/Species	Total Catch (kg)	% Total Catch
<i>Acanthuridae</i>	21,415	35
<i>Naso unicornis</i>	12,511	58*
<i>N. lituratus</i>	4,391	21*
<i>A. caesius</i>	1,458	7*
<i>A. xanthopterus</i>	776	4*
<i>Scaridae</i>	8,335	14
<i>Hipposcarus longiceps</i>	2,869	34*
<i>S. altipinnis</i>	1,029	12*
<i>S. schelegeli</i>	967	12*
<i>S. sordidus</i>	903	11*
<i>Kyphosidae</i>	2,001	3
<i>K. cinerascens</i>	2,001	100*
<i>Labridae</i>	3,133	5
<i>Chelinus undulatus</i>	2,497	80*
<i>Chelinus trilobatus</i>	406	13*
<i>Lethrinidae</i>	2,211	4
<i>Monotaxis grandoculus</i>	707	32*
<i>L. olivaceous</i>	471	21*
<i>Palinurus penicillatus</i>	1,888	3
<i>Lutjanidae</i>	1,445	2
<i>L. bohar</i>	996	69*
<i>Mullidae</i>	1,421	2
<i>Parupeneus barberinus</i>	749	53*
<i>Serranidae</i>	1,209	2
<i>Epinephelus fasciatus</i>	303	25*
<i>Siganidae</i>	1,091	2

<i>S. punctatus</i>	437	40*
<i>S. argenteus</i>	392	36*
<i>Trochus niloticus</i>	854	1
Octopus	840	1
<i>Carangidae</i>	605	<1
<i>C. melampygus</i>	249	41*
<i>Balistidae</i>	468	<1
<i>B. viridescens</i>	272	58*
Assorted Reef Fish**	10,957	18
Total	61,350	100

*% in respective Family **unable to obtain species breakdown

Comparing participation, the number of trips decreased 12%, 3,076 trips in FY99 compared with 3,515 trips in FY98, while the number of people spearfishing increased 6%, 10,702 people, compared with 10,054 people in FY98.

There were 1,919 snorkel spearfishing trips, 62% of all spearfishing trips in FY99 (See Table 7), a 26% decreased from FY98. Snorkel spearfishing harvest was 21.3 m.t., a slight decrease of 3% compared with 21.9 m.t. in FY98. Snorkel spearfishing averaged 1.37 trips a day, 0.75 trips on weekdays and 1.66 trips on weekends and holidays. Each trip averaged 3.3 hours and 3.2 fishermen, with an average CPUE of 1.31 kg/gr-hr. The change in CPUE is only a negligible 0.06 kg/gr-hr higher than with FY98. Hours spent snorkel spearfishing decreased 23%, 5,956 compared with 7,750 in FY98, the number of people fishing remained the same, while the number of gear hours decreased 7%, 16,295 compared with 17,455 in FY98. The most common species caught were the bluespine unicornfish, 3.2 m.t., the orangespine unicornfish (*N. lituratus*, 1.8 m.t.), and the gray unicornfish (*Naso caesius*, 1.3 m.t.), 15%, 8%, and 6% respectively of the total snorkel spearfishing catch. Approximately 3,799, or 18%, of the snorkel spearfish catch was estimated due to time constraints imposed by the fishermen.

TABLE 7: Comparison of Participation and Catch between snorkel spearfishing and SCUBA spearfishing during FY99.

Spearfishing Method	Number of Trips	Catch (mt)	Catch/Trip (kg/trip)	Catch/Gear Hr (kg/gh)
Snorkel Spear	1,919	21.3	11.1	1.31
SCUBA Spear	1,152	40.0	34.68	6.57
Total*	3,071	61.3		

*Excludes mixed spearfishing activity, which accounts for 5 trips and 129 kg during FY99.

SCUBA spearfishing had 1,152 trips during FY99, 37% of all spearfishing trips (Table 7). This is an increase of 27%, compared with 905 trips in FY98. SCUBA spearfishing account for 65% of the total spearfish catch, approximately 40.0 m.t., a 19% increased from the 33.7 m.t. caught in FY98. SCUBA spearfishing averaged 0.7 trips a day, 2.0 hours per fishing trip, 3.8 fishermen per trip, with an average catch rate of 6.57 kg/gear-hour and 34.68 kg/trip. The average catch rates of 6.6 kg/gear-hour and 34.7 kg/trip are slightly lower than FY98, 8% and 7% respectively. Hours spent SCUBA spearfishing increased 29%, 2,144 compared with 1,659 in FY98, the number of people engaged in SCUBA spearfishing increased 17%, 3,892 people compared with 3,317 people in FY98, while the number of gear hours increased 30%, 6,079 compared with 4,678 in FY98. The most common species caught by this method were the bluespine unicornfish, 9.3 m.t., the Pacific longnose parrotfish, 2.6 m.t., and the orangespine unicornfish, 2.6 m.t., the

humphead wrasse or Napoleonfish (*Cheilinus undulatus*, 2.4 m.t.), the highfin rudderfish (*Kyphosus cinerascens*, 1.4 m.t.), and the spiny lobster, 1.2 m.t.

Other Methods

Boat-based fishing methods other than trolling, bottomfishing, spearfishing, and jigging are regularly encountered during the offshore surveys. These methods often use boats to access fishing areas that are not easily accessible from shore. The most important boat-based methods in this category encountered during FY99 were the surround net (39.8 m.t.), gillnet (29.2 m.t.), castnet (2.2 m.t.), jigging (1.7 m.t.), and spincasting (1.0 m.t.). Approximately 78% of the catch in this category were atulai that were caught using gillnets and surround nets. Other major species caught by these methods were the reef blacktip shark (*Carcharhinus melanopterus*, 4.3 m.t.) the fringelip mullet (*Crenimugil crenilabis*, 2.0 m.t.), the yellow-spotted trevally (*Carangoides orthogrammus*, 0.7 m.t.), the bluefin trevally (*Caranx melampygus*, 0.7 m.t.), and the yellowstripe goatfish (*Mulloides flavolineatus*, 0.6 m.t.).

DISCUSSION

The total offshore catch for FY99 decreased slightly, 4%, compared with the total offshore harvest in FY98. Comparing only trolling, bottomfishing, atulai night-light jigging, and spearfishing, a 6% decrease in overall catch is observed.

Trolling showed an overall increase in participation, yet showed significant decreases in overall catch and CPUE. Comparing charter and non-charter trolling activity, the only increase was observed with the number of trips, persons, and hour spent fishing with non-charter boats. Bottomfishing, on the other hand, showed increases in participation, effort, and catch for both charter and non-charter bottomfishing. The CPUE for bottomfishing, especially for charter boats, is still considered significantly low. Snorkel spearfishing participation, effort, and catch, too, showed a general decrease compared with FY98. Despite the general decrease, a slight increase in CPUE (kg/gr-hr) was observed since the number of gear hours decreased proportionally less than the overall catch. SCUBA spearfishing participation, effort, and catch showed a general increase. However, the CPUE (kg/gr-hr) showed a decrease compared with FY98 since the number of gear hours increased proportionally more than the overall catch. On the other hand, atulai night-light jigging showed a significant decrease in catch, participation, and effort. The CPUE (kg/gr-hr), however, showed a significant increase since the gear hour decreased proportionally more than the overall catch decreased.

The increase in catch, participation, and effort of bottomfishing, combined with the continued unrestricted SCUBA spearfishing participation and effort could further negatively impact Guam's already over-utilized marine resources. A historic decrease in CPUE for bottomfishing and snorkel spearfishing is already observed, indicating a decrease in nearshore and reef-associated fish populations. Should an increase in bottomfishing, SCUBA spearfishing, and other boat-based fishing methods such as gillnetting continue, many important reef-associated species could be negatively impacted even further. SCUBA spearfishing presents a serious threat since a significant portion of the SCUBA spearfishing activity are commercial ventures that use state-of-the-art equipment, perform multi-tank dives as often as three times a week, and dive as deep as 50 meters. The FY99 SCUBA spearfishing catch could be underestimated since a significant portion of SCUBA spearfishing activity occurs at ports not surveyed, especially Ylig bay, which provides access to fishing resources on the east side of Guam. Individuals in these groups, too, possess bang sticks, using them to both fend off sharks and to take large individual fish. Unrestricted use of this method can become a serious threat to the fishery

by removing the large individuals of parrotfishes, groupers, and wrasses such as the Napoleonfish. During FY99, SCUBA spearfishing catch of Napoleonfish increased from 580ig to 2.4 metric tons. At this rate, the numbers of large individuals of this reef species, like the humphead parrotfish (*Bolbometapon muricatum*) and eight-banded grouper (*Epinephelus octofasciatus*), could be reduced significantly in a short period of time.

Charter boat activity is still suffering from the drastic drop in the number of tourists as a result of the Asian economic crisis and from present tourists seeking less expensive activities to do on Guam. Charter boats still account for a significant portion of the trolling activity, especially with blue marlin, which they target during the summer months.

During FY99, a significant increase was observed with deep bottomfishing. The estimated expanded catch for onaga, 6.7 metric tons, was due to a single highliner that did a significant amount of deep bottomfishing, reportedly in CNMI waters north of Guam.

RECOMMENDATIONS

The new survey design and computerized database analyzing the offshore data is still undergoing quality control and development. Although the inputting of all the historical offshore data is near completion, the data is currently undergoing several quality control tests to ensure than strata in the historical offshore data such as fishing method, deep versus shallow bottomfishing, and charter versus non charter fishing, are correctly inputted into the database. The new offshore expansion program will provide a standard methodology in order to obtain a more reliable history of the various offshore and reef-associated fisheries that are covered under the offshore fisheries project. It is recommended to continue working with NMFS on completing the offshore expansion program, entering historical data for re-expansion and analysis, and designing outputs that will be important in analyzing Guam's fisheries.

The interviews obtained in the offshore survey provide information including participation, effort, total catch, a species breakdown, sizes of individual fish, and area fished. Other important strata are charter activity and deep versus shallow bottomfishing. For mahimahi and species of *Scarus*, the historical and present data do, at times, record size and sex of individual fishes. The change in the size of pelagic fish and important reef-associated fishes such as groupers, parrotfishes, snappers, and wrasses should be analyzed to see if the effect of fishing pressure on particular species from the beginning of the offshore program. The historical data on size and sex of species of *Scarus* can be analyzed to see if fishing pressure has affected the size of reproducing individuals. The computer outputs to obtain this data should be completed with the assistance of NMFS during FY00.

PROGRAM COSTS

The estimated cost is approximately \$514,000.

Report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-7
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1998 through September, 1999. The total estimated inshore fisheries catch for this time period was 70.6 mt (metric tonnes), 89% of which were finfish (excluding the juvenile rabbitfish or mañāhak and juvenile fusilier or achemsom). Hook and line was the most practiced method accounting for 59% of the total participation (excludes seasonal mañāhak and atulai data) or 47,074 participants. In terms of catch rate, other methods were the most successful of all the daytime methods, yielding approximately 1.38 kg/gear-hour (gh) with a daytime harvest of 1.4 mt, and drag net was the most successful nighttime fishing method, yielding approximately 2.31 kg/gh with a nighttime harvest of 0.8 mt. Hook and line was the most successful method in terms of the overall harvest, yielding approximately 0.27 kg/gh with a total harvest of 23.4 mt. The seasonal mañāhak and achemsom catch was not surveyed in FY99.

Aerial Survey

The aerial survey report is included in Appendix 1.

Kid's Fishing Derby

The Kid's Fishing Derby report is included in Appendix 2.

Abandoned Gill Net Removal/Pilot Study

The gill net removal/study preliminary results, is included in Appendix 3.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. To identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational /

subsistence fishing activities have come to be based on more reliable data analysis techniques.

Data Analysis

The adoption of the 4th Dimension (4D) database program has greatly reduced the time needed to compile and analyze Guam's inshore survey data. This has allowed more time to upgrade data collection procedures and to ensure statistical reliability.

OBJECTIVES

- 1) To establish baseline catch and effort data for reef fish species necessary to develop a fisheries management plan for Guam.
- 2) To gather limited biological data on Guam's fisheries for management purposes.

PROCEDURES

During FY99, four "inshore-catch" survey days were selected per month. Fishermen-intercept interviews were conducted to determine amount of effort, fishing method, location, reef zone, species composition, and amount caught for both day and night fishing. The day survey covered a six-hour interval (beginning at 0630h) and the night survey covered a five-hour interval (beginning at dusk or 1900h). On any given survey day, one survey area (Figure 1), is randomly selected from either Gun Beach to Adelupe (region I: locations 1-11), Adelupe to Agat (region II: locations 12-34), or Pago to Merizo (region III: locations 71-41) and inshore data collection is restricted within the selected region. However, because of infrequently interviewed methods, e.g., surround netting, and low participation, representative samples can be difficult to obtain. Therefore, if this situation occurred, one or both of the other two adjacent areas could be surveyed.

During FY99, day and night "inshore-participation" surveys were conducted on four randomly selected days per month, which did not occur on the same days as the "inshore creel" surveys. These surveys entailed making visual observations of fishing participation within readily accessible portions of Guam's coastline (Fig. 1, locations: 1-21, 23-26, 29-35, 40-43, 51-57, 60-69, 71, 72). Fishing catch and effort data is collected by instantaneous counts, while driving in a continuous route, around the island. The route is alternated each survey between "clockwise" and "counterclockwise" and the starting locations are randomly selected (Fig. 1). Since the participation survey includes both day and night fishing, start times begin at 0630h and 1900h and end once the entire island circuit has been completed.

A new participation study was conducted from July to September 1999 to account for the participation and percent coverage of fishing methods that occurred during the inshore creel survey. Methods observed during the creel survey were listed according to the numbers of fishermen and gear for reef zones and locations within the survey route. The total number of method entries were compared to the non-interviews and calculated as a percent coverage for each method. The purpose of this study is to quantify the occurrence of methods during the creel survey.

Seasonal data on the scad mackerel (atulai), goatfish (ti'ao), and jacks (i'e') were acquired through actual participation and catch surveys. Species of fish that seasonally recruit *en masse* on Guam's reefs, i.e., juveniles of rabbitfish (mañâhak), and fusiliers (achemsom) were not entered into the database due to the sporadic nature of these fisheries.

Mañāhak *en masse* recruitment events are predicted to occur up to three times a year for approximately one week, depending on the overall size of the run. Recruitment events are expected to begin the day of or days following the fourth, fifth, and tenth last quarter moon phase. Recruitments of achemsom are irregular, but have been significant in terms of island-wide total harvest in certain years and usually recruit with mañāhak when they occur.



Figure 1. Inshore Fisheries "Participation Survey" Route with Area and Location Codes.

Atulai migrate into inshore areas throughout the year, which may cover a period lasting up to nine months. They usually enter protected locations, e.g., bays and channels, at daybreak and swim into deeper water before evening. A significant portion of the annual catch is not reported from this fishery because the larger net catches are sporadic and seldom appear on regular surveys.

Ti'ao and i'e' recruit annually on reef flats and make up a large portion of the annual catch and effort. Ti'ao generally recruit within a few days of the May full moon and during strong recruitment years, pulses of new recruits will also follow the June and July full moons. I'e' runs also follow the full moon starting in May and can continue after each full moon through November. It is speculated that continued recruitment may be linked to rainfall. Past recruitment events of these species have shown to be highly significant in terms of total catch, especially *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* with hook and line, and *Mulloides flavolineatus* and *M. vanicolensis* with nets, when they occur.

The FY99 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension (4D) database program. The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

During FY99, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 70.6 mt. Finfish accounted for 89% of total harvest or 62.7 mt. The seasonal mañahak and achemsom harvests were significant in certain locations on the east and west sides of the island during the months of April and May, e.g. East Agana, Pago Bay, and Merizo Pier, but were not recorded in FY99. The total inshore catch (finfish and invertebrates) resulted from a total effort of 269,950 person-hours (ph) and 235,057 gear-hours (gh). Overall, approximately 0.30 kg/gh of fish were harvested with 168 daytime and 226 nighttime species identified in FY99 (Table 1). In addition to seasonal species, a significant number of juvenile reef fish recruited on reefs in FY99. Species caught / observed (April/May 1999) in significant numbers included the following: *Epinephelus merra*, *Gnathodentex aurolineatus*, *Gymnosarda unicolor*, *Heteropriacanthus cruenatus*, and *Rhinecanthus aculeatus*.

Table 1. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY99.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	47,074	45,911	25,010	169,456	165,485	23,433	23,295	138	0.27 wd
Cast Net	9,897	9,097	7,971	23,230	21,354	7,613	7,220	393	0.54 wed
Gill Net	10,612	4,834	2,789	50,064	23,000	13,310	12,968	342	0.68 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	7,835	7,609	4,146	18,739	18,113	20,094	17,610	2,484	1.22 wen
Spear SCUBA	0	0	0	0	0	0	0	0	0.0
Drag Net	917	180	135	2,275	448	820	794	26	2.31 wn
Hooks & Gaffs	1,486	1,709	1,384	2,784	3,253	3,563	11	3,552	1.11 wd
Other††	2,586	2,586	1,796	3,403	3,403	1,798	791	1,007	1.38 wd
TOTAL	80,405	71,926	43,232	269,950	235,057	70,631	62,689	7,942	0.30

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), or weekend night (wen) values from Tables 2 and 3. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

CATCH

Hook and line fishing yielded the largest overall catch with 23.3 mt or 33% of the total finfish harvest. Snorkel spearfishing was second with 17.6 mt or 25%, while gill netting was third with 13.0 mt or 18%, and cast netting was fourth with 7.2 mt or 10% of the total finfish harvest (Table 1).

The top three daytime methods accounted for approximately 76% of the daytime total and 57% of the combined total harvest (Table 2). Hook and line fishing accounted for the most fish with 19.8 mt or 42% of the day finfish harvest. Gill netting was second with 10.8 mt or 23%, while snorkel spearfishing was third with 8.5 mt or 18%, and cast netting was fourth with 7.2 mt or 15% of the total day finfish harvest.

Table 2. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY99.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	33,615	33,254	19,583	117,909	116,698	19,829	19,777	52	0.27 wd
Cast Net	9,847	9,048	7,924	23,147	21,271	7,590	7,198	393	0.54 wed
Gill Net	6,575	3,181	1,988	35,539	17,052	11,035	10,806	228	0.68 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	3,399	3,233	2,295	9,162	8,672	9,332	8,514	818	1.08 wed
Spear Scuba	0	0	0	0	0	0	0	0	0.0
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	1,485	1,709	1,384	2,784	3,253	3,563	11	3,552	1.11 wd
Other††	2,119	2,119	1,627	2,072	2,072	1,429	719	710	1.38 wd
TOTAL	57,040	52,544	34,801	190,613	169,018	52,778	47,025	5,753	0.31

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) values. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

The top three nighttime methods accounted for approximately 93% of the night total and 24% of the combined total finfish harvest (Table 3). Snorkel spearfishing accounted for the most fish caught with 9.1 mt or 58% of the total night finfish harvest and hook and line fishing was second with 3.5 mt or 22%. Gill netting was third with 2.2 mt or 14% and drag netting was fourth with 0.8 mt or 5% of the total night finfish harvest.

Table 3. Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY99.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	13,459	12,657	5,427	51,548	48,787	3,604	3,518	86	0.11 wn
Cast Net	49	49	47	83	83	23	23	0	0.29 wn
Gill Net	4,037	1,652	802	14,524	5,948	2,276	2,162	114	0.39 wen
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	4,436	4,376	1,851	9,569	9,441	10,761	9,096	1,665	1.22 wen
Spear SCUBA	0	0	0	0	0	0	0	0	0.0
Drag Net	917	180	135	2,275	448	820	794	26	2.31 wn
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other††	467	467	169	1,331	1,331	369	72	297	0.66 wen
TOTAL	23,365	19,381	8,431	79,330	66,038	17,853	15,664	2,189	0.27

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) values. The greatest CPUE value for hook and line was in regions 1 and 2.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

EFFORT

Hook and line fishing was the most practiced fishing method overall (Table 1), accounting for 47,074 persons or approximately 59% of total participation. Gill netting was the

second most practiced method overall, accounting for 10,612 participants or 13%, while cast netting followed in third with 9,897 participants or 12% of the total participation.

The rank order for day fishing participation placed hook and line first with 33,615 or 59% participants. Cast netting and gill netting placed second and third respectively with 9,847 or 17% and 6,575 or 12% of the participants (Table 2). Hook and line fishing remained the most practiced night fishing method with 13,459 participants or 58% of night participation. The second most practiced method was snorkel spearfishing with 4,436 participants or 19%, while gill netting followed in third with 4,037 participants or 17% of night participation (Table 3).

CATCH PER UNIT EFFORT (CPUE)

Other methods had the highest daytime CPUE of 1.38 kg/gh for weekday fishing and hooks and gaffs followed in second with 1.11 kg/gh and snorkel spearfishing was third with 1.08 kg/gh (Table 2). Drag netting had the highest nighttime CPUE of 2.31 kg/gh for weeknight fishing, snorkel spearfishing followed in second with 1.22 kg/gh, and other methods was third with 0.66 kg/gh (Tables 1 and 3).

Summary information concerning effort and harvest for methods not discussed are included in Tables 1-3. Other nearshore fisheries harvests on Guam, including spear and net fishing off berthed and boats with trailers, were recorded in the FY99 Offshore Fisheries Report (Study F-1, Job 1).

Species and Family Harvests

The expanded species composition for the combined day and night efforts were calculated for FY99. The top species caught was the bluespine unicornfish, *Naso unicornis*, with 5.9 mt or 9.35% of the and *Caranx i'e'* was the top seasonal and overall species caught with 7.8 mt or 12.48% of the finfish total. Acanthuridae was the top family harvested, with 14.3 mt or 22.88% of the combined harvest in FY99 (Table 4).

Table 4. FY99 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm), *Mulloides flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day and night catch (62,689 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Caranx i'e'</i>	7,824.83	12.48	Acanthuridae	14,343.52	22.88
<i>Naso unicornis</i>	5,858.65	9.35	Carangidae	11,551.19	18.43
<i>Naso lituratus</i>	4,979.49	7.94	Scaridae	7,302.03	11.65
<i>Siganus spinus</i>	2,766.46	4.41	Siganidae	3,741.27	5.97
<i>Leptoscarus vaigiensis</i>	2,570.85	4.10	Mullidae	3,626.06	5.78
<i>Triaenodon obesus</i>	2,280.61	3.64	Carcharhinidae	2,845.84	4.54
<i>Caranx melampygus</i>	1,938.69	3.09	Mugilidae	2,640.48	4.21
<i>Gymnothorax javanicus</i>	1,422.77	2.27	Lethrinidae	2,214.09	3.53
<i>Acanthurus lineatus</i>	1,411.95	2.25	Muraenidae	1,789.45	2.85
<i>Mulloides ti'ao</i>	1,379.52	2.20	Kyphosidae	1,374.70	2.19
TOTAL ANNUAL COMBINED CATCH	32,433.82	51.74		51,428.63	82.04

Table 5. FY99 day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (47,025 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Caranx i'e'</i>	7,462.15	15.87	Carangidae	10,420.43	22.16
<i>Naso unicornis</i>	4,350.43	9.25	Acanthuridae	9,741.67	20.72
<i>Naso lituratus</i>	4,009.77	8.53	Scaridae	6,352.27	13.51
<i>Leptoscarus vaigiensis</i>	2,537.52	5.40	Siganidae	2,560.71	5.45
<i>Siganus spinus</i>	2,112.78	4.49	Mullidae	2,531.46	5.38
<i>Caranx melampygus</i>	1,814.16	3.86	Mugilidae	2,326.22	4.95
<i>Triaenodon obesus</i>	1,588.23	3.38	Carcharinidae	2,130.32	4.53
<i>Gymnothorax javanicus</i>	1,323.53	2.81	Muraenidae	1,579.03	3.36
<i>Mulloides ti'ao</i>	1,276.36	2.71	Lethrinidae	1,471.83	3.13
<i>Kyphosus vaigiensis</i>	1,192.26	2.54	Kyphosidae	1,325.29	2.82
TOTAL ANNUAL DAY CATCH	27,667.19	58.84		40,439.23	86.00

Naso unicornis topped the night harvest with 1.5 mt (99% by snorkel spear and 1% by hook and line) or 9.63% and *Acanthurus lineatus* was slightly less with 1.3 mt or 8.49% of the night total. Acanthuridae was harvested over 4 times greater than any other family with 4.6 mt or 29.38% of the top family with 4 species making the top ten night harvest list (Table 6).

Table 6. FY99 night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (15,664 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Naso unicornis</i>	1,508.22	9.63	Acanthuridae	4,601.85	29.38
<i>Acanthurus lineatus</i>	1,329.39	8.49	Siganidae	1,180.56	7.54
<i>Naso lituratus</i>	969.72	6.19	Carangidae	1,130.76	7.22
<i>Triaenodon obesus</i>	692.38	4.42	Mullidae	1,094.60	6.99
<i>Mulloides flavolineatus</i>	662.80	4.23	Scaridae	949.76	6.06
<i>Siganus spinus</i>	653.68	4.17	Lethrinidae	742.26	4.74
<i>Caranxi'e'</i>	362.68	2.32	Carcharinidae	715.52	4.57
<i>Lutjanus argentimaculatus</i>	358.48	2.29	Lutjanidae	592.43	3.78
<i>Acanthurus triostegus</i>	356.12	2.27	Holocentridae	582.37	3.72
<i>Lethrinus xanthurus</i>	353.05	2.25	Labridae	334.54	2.14
TOTAL ANNUAL NIGHT CATCH	7,246.52	46.26		11,924.65	76.13

Method Harvests

The top harvest of finfish species for hook and line method was calculated for FY99 (Table 7). *Caranx i'e'* ranked first with 6.0 mt for day (30.52%) and second with 0.3 mt (7.12%) for night, while *Traenodon obesus* ranked first with 0.7 mt (19.68%) for night only. A 15.0 kg whitetip shark skewed the night hook and line expansion results.

Table 7. FY99 day and night catch composition for the top ten species of finfish harvested by hook and line method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (19,777 kg) and night (3,518 kg) hook and line catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Caranx i'e'</i>	6,035.81	30.52	<i>Triaenodon obesus</i>	692.38	19.68
<i>Naso unicornis</i>	2,177.68	11.01	<i>Caranx i'e'</i>	250.56	7.12
<i>Caranx melampygous</i>	1,670.29	8.45	<i>Lutjanus argentimaculatus</i>	343.21	9.76
<i>Triaenodon obesus</i>	1,588.23	8.03	<i>Selar crumenophthalmus</i>	273.39	7.77
<i>Naso lituratus</i>	1,581.24	8.00	<i>Lethrinus xanthurus</i>	244.26	6.94
<i>Gymnothorax javanicus</i>	1,323.53	6.69	<i>Trachinotus blochii</i>	230.99	6.57
<i>Liza vaigiensis</i>	814.34	4.12	<i>Heteropriacanthus cruenatus</i>	207.76	5.91
<i>Siganus spinus</i>	726.77	3.67	<i>Siganus argenteus</i>	149.44	4.25
<i>Lethrinus harak</i>	382.34	1.93	<i>Caranx melampygus</i>	126.70	3.60
<i>Scomberoides lysan</i>	381.60	1.93	<i>Lethrinus harak</i>	112.99	3.21
Total Top Ten Hook & Line Catch	16,681.83	84.35		2,631.68	74.81
Total Combined Hook & Line Catch	19,313.51				

The top harvest of finfish species for gill net method was calculated for FY99 (Table 8). *Leptoscarus vaigiensis* ranked first for day with 2.5 mt (23.01%) of the daytime harvest. An unusually large gill net harvest of 33.0 kg of the seagrass parrotfish, skewed the day expansion results. *Mulloides flavolineatus* ranked first with 0.2 mt (10.9%) of the night harvest.

Table 8. FY99 day and night catch composition for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (10,806 kg) and night (2,162 kg) gill net catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Leptoscarus vaigiensis</i>	2,486.29	23.01	<i>Mulloides flavolineatus</i>	235.61	10.90
<i>Scarus psittacus</i>	866.57	8.02	<i>Siganus randalli</i>	189.29	8.76
<i>Siganus spinus</i>	720.29	6.67	<i>Siganus spinus</i>	188.83	8.73
<i>Acanthurus triostegus</i>	675.28	6.25	<i>Acanthurus triostegus</i>	140.08	6.48
<i>Lethrinus harak</i>	476.10	4.41	<i>Leiognathus equulus</i>	110.98	5.13
<i>Carcharhinus melanopterus</i>	471.27	4.36	<i>Gerres acinaces</i>	109.35	5.06
<i>Naso unicornis</i>	442.06	4.09	<i>Valamugil engeli</i>	100.87	4.67
<i>Gerres acinaces</i>	440.73	4.08	<i>Kuhlia rupestris</i>	94.71	4.38

<i>Parupeneus barberinus</i>	342.18	3.17	<i>Caranx i'e'</i>	78.17	3.62
<i>Mulloides flavolineatus</i>	339.67	3.14	<i>Valamugil seheli</i>	55.31	2.56
Total Top Ten Gill Net Catch	7,260.44	67.19		1,303.20	60.28
Total Combined Gill Net Catch	8,563.64				

The top harvest of finfish species for snorkel spear method was calculated for FY99 (Table 9). *Naso lituratus* ranked first with 2.1 mt (24.14%) and third with 0.9 mt (10.44%), while *Naso unicornis* ranked second with 1.7 mt (20.33%) and first with 1.5 mt (16.4%) of the day and night snorkel spear harvest.

Seasonal Harvests

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The FY99 harvests of i'e' and ti'ao were well represented within the expansion estimates (Tables 4-6), especially *Caranx i'e'*. During FY99, small pulses of recruiting ti'ao occurred in November and July and i'e' occurred from March - September. I'e' (*Caranx* spp.) ranked first for overall and daytime harvests (Tables 4 and 5) and ranked seventh for the night harvest (Table 6) in FY99. Ti'ao (*Mulloides flavolineatus*) ranked tenth for overall harvest (Table 4) and ninth for daytime harvest (Table 5) in FY99.

FY99 marked a significant recruitment year for mañahak (ha'tang or *Siganus spinus* and lessso' or *S. argenteus*). Runs occurred in early April and May of FY99. As of June 1998, DAWR suspended the collection of mañahak harvest data, because this information was not critical to management of the reef fishery. DAWR staff observations and personal accounts from local fishermen interviewed during the creel surveys harvested mañahak on the following dates in 1999: April 12, May 1, 7-11, 16-19, and May 9-12.

Table 9. FY99 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (8,514 kg) and night (9,096 kg) snorkel spear catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Naso lituratus</i>	2,055.28	24.14	<i>Naso unicornis</i>	1,491.81	16.40
<i>Naso unicornis</i>	1,730.69	20.33	<i>Acanthurus lineatus</i>	1,315.83	14.47
<i>Scarus schlegeli</i>	898.67	10.56	<i>Naso lituratus</i>	949.56	10.44
<i>Siganus argenteus</i>	425.99	5.00	<i>Siganus spinus</i>	437.90	4.81
<i>Scarus altipinnis</i>	359.04	4.22	<i>Scarus psittacus</i>	233.09	2.56
<i>Scarus sordidus</i>	287.42	3.38	<i>Acanthurus triostegus</i>	215.83	2.37
<i>Hipposcarus longiceps</i>	271.85	3.19	<i>Cheilinus trilobatus</i>	206.69	2.27
<i>Lutjanus argentimaculatus</i>	266.56	3.13	<i>Scarus schlegeli</i>	161.41	1.77
<i>Caranx papuensis</i>	246.16	2.89	<i>Scarus frontalis</i>	136.57	1.50
<i>Kyphosus vaigiensis</i>	233.77	2.75	<i>Naso tuberosus</i>	136.49	1.50
Total Top Ten Spear Snorkel Catch	6,775.43	79.58		5,285.18	58.10
Total Combined Spear Snorkel Catch	12,060.61				

The atulai (*Selar crumenophthalmus*) season was exceptional during the last few months in FY99, but did not reflect this during the creel surveys with 0.3 mt or 0.5% of the total catch for FY99. The total inshore harvest of atulai (94% of day and night harvest) were caught with hook and line, due to the high incidence of catch interviews at the Agana Boat Basin channel (Fig. 1, location 9 and Table 7).

Invertebrates Harvested

In addition to finfish, a significant number of marine invertebrates were harvested from Guam's reefs. An estimated 5.7 mt of octopus, e.g., *Octopus cyanea* (0.9 mt) and *O. ornatus* (4.9 mt), which made up approximately 74% of the total invertebrates harvested, were caught island-wide in FY99. Daytime octopus harvests accounted for 4.7 mt (75% by hooks and gaffs, 16% by snorkel spear, 8% by cast nets, and 1% by gill nets), while nighttime harvests accounted for 1.1 mt (93% by snorkel spear, 3% by gill nets, and 2% by other methods and drag nets) in FY99.

The spiny lobster, *Panulirus penicillatus*, was the second most harvested invertebrate with a day and night island-wide harvest of 0.5 mt (74% by snorkel spearfishing and 26% by gill net) in FY99. The third most caught invertebrate was the longspine urchin, *Echinothrix diadema*, with an estimated 0.3 mt (100% by other methods) in FY99. Harvests of reef molluscs, crustaceans, and echinoderms accounted for an estimated 6.3 mt, 1.0 mt, and 0.3 mt respectively, in FY99.

Other methods, e.g., gleaning, crab trapping, and hand netting, produced an estimated 1.8 mt of finfish and invertebrates, e.g., Chaetodontidae for the aquarium trade and *Echinothrix* sea urchins for "uni", with a catch rate of 0.3 kg/ph of fishing effort.

Harvests were not representative of the actual participation, due to the rarity of certain methods within the "inshore-catch" survey window (especially nighttime for certain methods), and includes the following methods for day: surround net, spear SCUBA, and drag net; and for night: cast net, surround net, spear SCUBA, and hooks and gaffs. Methods encountered more frequently, i.e., hook and line, cast net (day only), gill net, spear snorkel, hooks and gaffs (day only), drag net (night only), and other methods, had expansion confidence intervals less than 48.2% for daytime and less than 57.5% for nighttime fishing activity.

An Inshore Creel Participation pilot survey was conducted from July to September 1999 to identify methods rarely interviewed. Percent coverage of persons and gears were listed for all methods encountered during the creel survey with results listed in Table 10. Methods with the least number of persons observed included the following for weekday and weekend surveys respectively: SCUBA spear (0/2), surround net (3/6), other methods (4/3), and drag net (5/7). Percent summaries (Table 10) of the previously mentioned methods do not accurately reflect the actual coverage throughout the fiscal year, i.e., SCUBA spear was listed at 100% coverage for weekend surveys based on two observations, which was an inadequate amount of data to expand on 4D. In addition, surround net fishing was not expanded for total harvest in FY99 due to the rarity of this method.

Table 10. Inshore Creel Participation Survey Results. Method abbreviations are listed as follows: Hook and Line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM) for July – September 1999. Percent values illustrate rarely encountered and interviewed methods.

Inshore Creel Participation

Methods	Total # Observed Methods				Total # of Non-Interviews				%Summary			
	Persons		Gears		Persons		Gears		%Persons		%Gear	
	WD	WE	WD	WE	WD	WE	WD	WE	WD	WE	WD	WE
HL	200	265	203	259	38	79	37	83	81	70	82	68
CN	16	18	10	14	1	8	1	7	74	56	90	50
GN	47	62	21	31	24	40	12	18	49	35	43	42
SN	3	6	1	6	3	2	1	2	0	67	0	67
SpSn	13	16	13	16	6	4	6	4	54	75	54	75
SpSc	0	2	0	2	0	0	0	0	0	100	0	100
HG	14	15	17	12	6	14	5	11	57	7	71	8
DN	5	7	1	2	0	7	0	2	100	0	100	0
OM	4	3	4	3	0	3	0	3	100	0	100	0

Fishable Index Hours (FIH)

The FIH default is a parameter used in the expansion to identify the amount of time a person can fish with a particular method during a survey day. Windows of survey fishable time included: the a.m. (0600-1200 hours), p.m. (1900-2400 h), whole day (0600-1800 h), and whole night (1900-0200 h). The FIH is determined by dividing the survey fishable time by the whole day fishable time for each method. Fishable hours for each method are determined by the state of the tide. Some methods are not restricted by tide, e.g. hook and line and spearfishing. Net fishing and is limited to tides above 0.5 ft., while hooks and gaffs for octopus and other methods are limited to tides below 0.5 ft (Table 11).

Table 11. Fishable Index Hours (FIH). Methods are listed as follows: Hook and Line (HL); Cast, Gill, Surround, and Drag Nets (N); Snorkel and SCUBA spear (SP); Hooks and Gaffs (HG); and Other Methods (OM), are listed for day and nighttime values for FY99.

Daytime FIH Values for FY99

Method	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep
Nets	2.48	2.20	2.28	2.20	2.20	2.20	2.10	2.05	1.85	1.71	2.21	2.18
HG	1.00	1.00	1.00	1.00	1.00	1.00	1.50	1.75	2.75	2.88	2.44	1.50

Nighttime FIH Values for FY99

Nets	1.25	1.31	1.29	1.63	1.31	1.58	1.71	1.54	1.50	1.50	1.50	1.50
HG	2.00	1.92	2.13	1.06	1.75	1.13	1.00	1.00	1.00	1.00	1.00	1.00

	Day	Night
HL	2.00	1.40
SP	2.00	1.40
OM	2.00	2.00

RECOMMENDATION

Considering the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Since approximately 14% of the participants and gear-units are not surveyed on the inshore participation route (based on FY99 data), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and an improved quantitative analysis has been completed for island-wide inshore fishing effort.

The increased availability and affordability of certain fishing gear methods has also changed on Guam. Hook and line has shown a significant increase since the early 1980's and has grown in popularity, especially with the i'e' and atulai fishery. Gill net use has remained high over the last decade, but the poor quality and disposability of the cheaper nets has created a situation of "ghost-netting" on our reefs. An abandoned gill net removal/study has been recommended as a separate new project and approved for FY00. This project will address the need to remove derelict nets and to quantify the destruction to marine organisms and coral reef habitat. A three-month pilot study was conducted from July to September 1999 to determine project feasibility with the summary and results included in Appendix 3.

SCUBA spearfishing has increased in popularity with the aid of depth finders, bang sticks, and greater volume airtanks. In addition, it is known that certain species of reef fish, e.g., *Cheilinus undulatus* (Humpheaded Wrasse) and *Bolbometopon muricatum* (Humpheaded Parrotfish), have become increasingly rare due to the use of bangsticks with this method (per com with commercial SCUBA spearfishermen). In FY00, a study will be conducted to address key management issues related to this method.

Overall declines in annual harvests and shifts in species composition have been documented in the last fifteen fiscal years. With the recent legislative approval of marine preserves and the implementation of new fishing regulations, we can begin to manage destructive fishing methods and preserve critical areas for reef fishes to mature and reproduce. As the success of the marine preserves are documented over the next few years, the evidence needed to restrict the most destructive methods, e.g. gill nets, drag nets, and SCUBA spearfishing, will be possible.

There may be an immediate need to modify inshore survey locations in the near future with the implementation of 5 new marine preserves on Guam. This may require the addition of approximately 5 new locations adjacent to the regions currently surveyed, e.g. locations 91, and 92 to region I; 35 to region II; and, 39 and 73 to region III, (Fig. 1).

PROJECT COST

The estimated cost of this project was \$159,000.

Report prepared by: Todd J. Pitlik

APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

A total of 23 inshore aerial surveys were conducted in FY99 for a total of 1,563 persons and 1,360 gear units. Hook and line was the most frequently encountered method with 848 persons and 841 gear units. A ratio of participants / method observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 65% for weekend hook and gaffs to 100% for rare and night-practiced methods, e.g., surround net, drag net, other methods, and SCUBA spear fishing.

Incidental biological sightings resulted in a total of 211 turtles, 639 dolphins, 29 sharks, 22 eagle rays, 3 manta rays, and 2 sting rays for FY99.

BACKGROUND

Inshore fishing surveys have been conducted by the Division of Aquatics and Wildlife Resources (DAWR) since the early 1960's, to monitor and collect a long-term database on the total fishing effort and catch from Guam's reefs. The inshore-catch and inshore-participation surveys were developed to collect catch and effort data in near-shore areas easily accessible by motor vehicle. In addition, the inshore-aerial survey was established in the early 60's and reinstated in FY90 to survey effort in areas that could not be easily accessed by a vehicle.

PROCEDURES

"Inshore-aerial" surveys were conducted twice monthly on regularly scheduled participation days (one weekday / weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig.1 locations: 22, 27, 28, 35-39, 44-50, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200-300m with an altitude of 170-200m. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method and type day (weekday / weekend). A ratio of the persons / method observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island for each type day. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Pago Bay and the fore reef slope, along the aerial survey route.

RESULTS

The most frequently encountered methods included hook and line, cast net, gill net, snorkel spear, hooks and gaffs, and other methods, while surround net, spear SCUBA, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., spear SCUBA and drag net are primarily night methods. Hook and line, cast net, gill net, surround net, snorkel spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) listed as percentages: (91 / 82), (82 / 70), (88 / 96), (100 / 100), (82 / 86), (85 / 65), and (74 / 93), respectively for FY99.

Table 1. P_2 values derived from aerial survey data in FY99. Ratios were calculated from a ratio of method sightings within aerial locations to participation locations. Methods abbreviations are listed as follows: Hook and Line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	20/210	8/37	6/43	0/10	14/65	0/0	2/11	0/0	7/20
Weekend	111/507	13/31	6/144	0/71	22/139	0/0	7/13	0/0	3/43
WD Ratio	210/230	37/45	43/49	10/10	65/79	0/0	11/13	0/0	20/27
WE Ratio	507/618	31/44	144/150	71/71	139/161	0/0	13/20	0/0	43/46
WD P_2	91	82	88	100	82	100	85	100	74
WE P_2	82	70	96	100	86	100	65	100	93

Aerial survey counts indicated hook and line with the greatest number of participants in FY99 (Table 2).

Table 2. Total number of people and gear units observed during aerial surveys in FY99. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) days listed below.

Methods	Within Par Route				Outside Par Route			
	Persons		Gears		Persons		Gears	
	WD	WE	WD	WE	WD	WE	WD	WE
HL	210	507	210	500	20	111	20	111
CN	37	31	34	30	8	13	5	13
GN	43	144	19	53	6	6	4	3
SN	10	71	2	10	0	0	0	0
SpSn	65	139	65	139	14	22	14	22
SpSc	0	0	0	0	0	0	0	0
HG	11	13	11	13	2	7	2	7
OM	20	43	20	43	7	3	7	3
Total	396	948	361	788	57	162	52	159

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with 639 sightings. The greatest monthly total of 262 dolphin sightings occurred

in July. Turtle, shark, and eagle ray sightings ranked second, third, and fourth, respectively with annual sightings. The greatest monthly total of turtles and sharks were sighted in September with 67 and 14 respectively and eagle rays in October with 11. In addition, a total of 3 manta rays and 2 stingrays were sighted in FY99 (Table 3).

Table 3. Number of turtle, dolphins, shark, and ray sightings by aerial surveys around Guam in FY99.

SPECIES	MONTHS												TOTAL
	O	N	D	J	F	M	A	M	J	J	A	S	
Turtle	27	10	3	17	14	8	12	6	13	26	8	67	211
Dolphin	40	0	3	30	52	30	6	75	75	262	25	41	639
Shark	1	1	1	5	2	1	2	0	0	0	0	14	29
Sting Ray	0	0	0	0	0	0	0	0	0	0	2	0	2
Eagle Ray	11	4	1	1	0	0	0	3	1	1	0	0	22
Manta Ray	0	0	0	0	0	1	0	1	0	1	0	0	3

Cancellation due to poor weather conditions occurred only once on in FY99, which was on 4/27/99.

RECOMMENDATION

An aerial survey study should be conducted to determine the best route (outer reef margin or mid-reef flat) to observe fishing methods. In addition, there is a need to train office personnel on how to conduct the aerial survey. This will help reduce the number of cancelled surveys when the primary investigator is not available.

PROJECT COST

Flights cost approximately \$10,780.

Report prepared by: Todd J. Pitlik

APPENDIX 2

KID'S FISHING DERBIES

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

One fishing derby was held in FY99, which was a one-day event at Sirena Beach, AAFB on May 31, 1999. To date, six marine derbies have been co-sponsored by DAWR and AAFB. Twenty-five children participated in this year's event.

OBJECTIVES

To encourage fishing as a form of recreation for children by promoting at least two kids fishing derbies per fiscal year, and to use these events as opportunities to teach environmental and fishing conservation ethics.

PROCEDURES

Coordination and Logistics

Coordination of the event involved preparation and planning at least 4-6 weeks in advance. A fishing site had to be selected that provided safe shoreline fishing for the participants and habitat for fish. A date had to be selected to ensure a high tide during the fishing event to increase the chances of catching fish. Chief Conservation Officer Kelly Knutson of Andersen Air Force Base and DAWR Fisheries Biologist Veronica Cummings were the designated points of contact for this kid's derby.

Logistics included following: rest areas with chairs and tables as well as refreshments; staff to serve as officials; organizing a safety briefing and the awards ceremony; and ensuring that official representatives from both agencies were present for the awards presentation.

Advertisements

The advertising strategy employed intended to ensure maximizing derby exposure to children ages seven to twelve both on and off base. This was done by providing flyers to all elementary and middle schools, having highway banners displayed in strategic locations, providing the media with press releases periodically, and making derby pitches through various radio talk shows. Kid's fishing derbies held in cooperation with military installations had individuals from both agencies serving as points of contact. This ensured that requirements of both agencies were met and that duties assigned to each agency were completed.

Derby Rules and Clinic

The derby had a harvest size limit and a bag limit for the fish caught to encourage the practice of conservation. Fish had to be over 6 inches (152 mm) in length in order to qualify for the derby awards and to be kept. Although there was an individual bag limit of five fish, participants were encouraged to practice "catch and release" during the event.

The derby was open to children from seven to twelve years of age, and was preceded by a fishing clinic open to the public on May 24, 1999.

The fishing clinic provided an opportunity for parents and children to learn about and practice basic fishing skills including knot-tying and casting. Demonstrations were also conducted to aid parents in selecting and purchasing fishing gear and in preparing for the fishing event. A highlight in this year's clinic was a casting contest held for the longest cast and most accurate cast. Winners were awarded during a ceremony held at the end of the derby.

RESULTS

Twenty-five children participated in this year's event. Certificates of Participation and fish posters were provided to all participants. A draft post-derby report has been completed, which includes comments and suggestions from derby participants to improve future derbies. Food was also donated by businesses, with donuts and soft drinks being provided as refreshments.

Prizes for the derby were solicited for a two-day event in accordance with Executive Order 91-08, resulting in thirty-seven prizes being donated. Since there were only five winners from the actual fishing, the remaining prizes were distributed by lottery to the non-winners (Table 1).

Table 1. FY99 Kid's Derby Winners.

MOST FISH

1st Place	Rikayah Flores	1 fish
2nd Place	Jenin Saleh	1 fish

LONGEST FISH

1st Place	Raymond Blas	21 inch Peppered Moray
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LONGEST TRIGGERFISH

1st Place	Jay Horton	7.5 inch Wedge Picassofish
2nd Place	Abed Saleh	5.5 inch Picassofish

RECOMMENDATIONS

Evaluations and Comments

1. Great, have them more often. D. Saleh
2. Excellent Program; Good coordination with fishing clinic. Fish not cooperating. Maybe include class on types of lures and how to attach bait.
3. Well conducted (wish there were more fish!)
4. Just make more fishing derbies both in "Fresh & Ocean" waters.
5. Thank you for giving my nephew the opportunity to fish on the AAFB beach. I commend all who took time away from their families to host this derby. I think that the times should be changed to approx. 9-11 a.m. Thank you to all! Mark Almandres (Angler)

6. Great job! See you next year! Blas
7. The next fishing derby should be one at Fena Lake where there are more fish to catch.
8. This program is indeed an exciting and experiencing way for children to enjoy fishing. This was my children's first time and we just wanted them to have fun and experience something different. I believe they did enjoy themselves. The supporting staff and individuals who made this possible. I appreciate you, to a job well done!
9. My son fished once, but he stood outside of site, on the right. For safety reason, we agreed with you for enjoyable please think about fishing place. We didn't know when you had a fishing derby this year until I read the newspaper just a few days before. If you advertise it more, more participants will join.
10. The event is great for kids, please continue to have one or more yearly. We thank you for having a fishing derby. My son really enjoyed himself. See you next year. J. Blas (son)
11. I thought I had like 10 feet long but it was stuck by a rock and my friend got it. Suguru Nakanishi
12. It was very very fun. Even though I couldn't catch any fish. I enjoyed watching other people catch different fish. I hope the next time I come I can catch a fish! Yoichi Nakanishi
13. This is my third year and it's been great.
14. This is my third time at this event. It's been a great time again. Just one suggestion: How about having the next one in the evening or afternoon? Scott Klassen
15. Good work. Good program.

The derby program has been well received and is a valuable educational tool for those who participate. However, an increase in the number of participants is essential for the program to effectively continue. This can be achieved by adding radio advertisements to our other methods of advertising. In addition, hosting more events and targeting special groups like the Boy Scouts, Girl Scouts, or village programs could work well.

Another factor concerning participation in derbies is to find a location that is more centrally located, instead of going to strictly military sites.

The response from participants and parents was positive. There have been requests by participants and parents to include a category for teenage anglers. Some of the older participants are interested in staying in the program, while some parents have older children who usually help their younger siblings to fish. This might help in making the derby more family oriented and decrease the chance of turning away potential participants.

PROJECT COST

The estimated cost of this project was \$1,000.

Report Prepared by: Veronica Cummings

APPENDIX 3

ABANDONED GILL NET REMOVAL/STUDY

PERIOD COVERED: July to September 1999

SUMMARY

Abandoned gill nets were retrieved from seven locations (Fig. 1) on Guam from July to September 1999. A total of 22 nets were recovered with an average mesh size of 1.75 in. and a total length of 1,232 ft. Of the 22 nets collected, 14 were identified to contain incidental catches of marine organisms and coral with a total of 5.66 kg of invertebrates, 0.05 kg of reef fish, and 53.79 kg of marine algae. Live corals and coral rubble fragments were also recovered for a total of 2.0 kg and 25.0 kg respectively.

OBJECTIVES

1. To identify and remove abandoned gill nets on reefs around Guam reported by fishermen and concerned citizens.
2. To collect data related to the destruction of reef habitat and incidental catch of marine organisms caused by abandoned gill nets.
3. To analyze data and identify locations affected by abandoned gill nets and evaluate the need for effective management related to this occurrence.

PROCEDURES

Information on the location and condition of abandoned gill nets were obtained during creel surveys from July to September 1999. Net location was verified by staff following the survey and removed at a later date. Gill net, marine organism, and coral habitat data was collected to quantify damage to organisms and coral. Data included locality, reef zone, water depth, additional remarks, coral and habitat damage (before and after net removal), and marine organisms collected (condition, length, weight, and species identification). Marine organisms capable of survival were released.

RESULTS

A summary of abandoned gill net collection data from July to September 1999 is included in Table 1. Data was subdivided into the following categories: nets, marine organisms, and habitat damage. Abandoned gill nets were located in seven inshore locations and collection data was summarized for each one. Location 67 (Fig. 1) had the greatest number of abandoned gill nets collected for a total of 14. Invertebrates comprised the majority of the incidental catch with 5.66 kg. Released invertebrates included the following: 55 *Holothuria atra*, 1 *Conus lituratus*, 1 *Zosymus aeneus*, and 1 *Ateragatis subdentatus*. In addition, approximately 54.0 kg of marine algae (primarily *Sargassum* and *Turbinaria*), 2.0 kg of live coral fragments, and 25.0 kg of rubble were collected during the study period.

RECOMMENDATION

Damage to coral habitat was difficult to quantify in the field, due to the absence of a standard measure. Photo documentation and cooperative efforts with UOG marine lab personnel should improve habitat assessment. The significant number of abandoned gill nets collected over the three month study period emphasize the need for continued removal and to further document the incidental catch and damage to coral habitats on Guam.

Table 1 Summary data of abandoned gill nets collected from July to September 1999.

NETS	LOCATIONS							Σ
	13	16	49	53	63	67	71	
Number	1	1	1	1	1	14	3	22
Avg Mesh (in)	1.5	2.0	2.5	2.0	1.5	2.4	3.1	1.75
Length (ft)	100	10	300	100	100	516	106	1,232
SPECIES								
# Fish	1	0	0	0	0	1	0	1
Fish (kg)	0.05	0	0	0	0	1	0	0.05
# Inverts	4	0	59	0	0	10	0	73
Inverts (kg)	0.33	0	3.89	0	0	1.44	0	5.66
Algae (kg)	2	1	12.04	0	4.5	34	0.25	53.79
HABITAT DAMAGE								
# Corals (Live)	N/A	N/A	2†	N/A	N/A	N/A	N/A	2
Dead Coral (kg)	N/A	N/A	∂	N/A	N/A	N/A	⊠	25

†*Porites cylindrica* – estimated 2.0 kg at 120 mm each.

∂Coral Rubble – estimated 20.0 kg.

⊠*Acropora danai* – estimated 5.0 kg.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-7
SUB-PROJECT NO.: F-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Freshwater Monitoring (2440)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

During FY99, the ongoing monitoring of four previously selected watersheds continued. Faunal counts and habitat characteristics recorded in FY99 are summarized in this report. The influence of Fena Reservoir on migrating fauna continues to be assessed. The results of the FY97 study were used as baseline data in comparative analyses with data collected in FY99. Preparations were completed in FY99 for a stock assessment of Fena Reservoir to begin in FY00. A weir-like net, trolling motors, and deep-cycle marine batteries were purchased and tested. The working draft of a freshwater field guide continues to be updated. A digital camera and software purchased in FY99 will be used to produce and edit photos for the field guide. The option of commissioning photos from a professional photographer is also being explored.

BACKGROUND

1-2. Maintaining high quality watershed ecosystems is essential to protecting healthy coastal areas that support fisheries. In order to monitor the quality of Guam's watershed ecosystems, biological and physical baseline data were collected from the following four watersheds in FY97: 1) Fena; 2) Manenggon; 3) Ylig; and 4) Pago. Annual monitoring of these parameters is essential for the effective watershed management necessary for the protection of Guam's coastal resources. Further explanation regarding the purpose of this project and additional background information can be found in Freshwater Monitoring Annual Report (F-1R-5, F-2, 1-1).

3. Fena Reservoir was completed in 1951 to provide a dependable water supply for the U.S. Navy on Guam (BioSystems Analysis, 1990). By 1955, pond weed (*Potamogeton crispus*) and bladderwort (*Utricularia* sp.) had become established near the banks and especially in the shallow waters at the back end of the reservoir (depths of 15 ft. or less)(Brock and Yamaguchi, 1955). In order to control these plants, 2 species of tilapia (*Oreochromis mossambicus* in 1956, *Tilapia zillii* most likely in 1957) were introduced into the reservoir (Brock and Takata, 1956; Nelson and Eldredge, 1991). Between 1962 and 1968 other species, including tucunare (*Cichla ocellaris*), small mouth bass (*Micropterus dolomieu*), large mouth bass (*Micropterus salmoides*), and channel catfish (*Ictalurus punctatus*) were introduced to control the stunting of the tilapia and/or to increase angling opportunities. Mosquito fish (*Gambusia affinis*; some time before 1955) and guppies (*Poecilia reticulata*; in 1956) were also introduced to the reservoir for the control of mosquitoes (Brock and Yamaguchi, 1955; Brock and Takata, 1956). Surveys to monitor the status of the introduced species ended in 1969, and since that time, no stock

assessments have been conducted in Fena Reservoir. Additionally, other species, such as unwanted aquarium pets, have been deposited in the lake over the years. In order to determine the status of both native and introduced species, an extensive stock assessment project will commence in FY00. Preparations began in FY98 and continued in FY99, with the research of various methods, the development of a project plan, and the design and purchase of the necessary equipment, including a weir-like net, electric trolling motors (gasoline powered motors are prohibited in the reservoir), and deep-cycle marine batteries.

4. Knowledge of and interest in freshwater species is limited on Guam. To increase awareness of these important organisms and their habitats, educational materials, such as a field guide and posters, need to be developed.

OBJECTIVES

1. Continue to survey the four watersheds chosen in FY97 in order to monitor the health of stream ecosystems on Guam.
2. Continue to monitor the effect of Fena Reservoir on faunal migration.
3. Continue preparations for a stock assessment of Fena Reservoir.
4. Continue the development of a more extensive freshwater field guide, building on information collected in FY97 and FY98.

PROCEDURES

- 1-2. Species composition, organism density, and habitat characteristics were collected in the experimental and control rivers chosen in FY97, using the methods described in the annual report of FY97. The experimental rivers, located above Fena Reservoir, are: the Almagosa River, the Maulap River, and the Sadog River. The control rivers are: the Maagas River, the Manenggon River, the Pago River, and the Ylig River. When possible, analysis of variance was used for data comparison of the streams. However, when the data did not conform to the assumptions of ANOVA, appropriate nonparametric tests were performed (StatView 4.51, Abacus Concepts, Inc., Berkeley, California, 94704-1014).
3. Preparations for the stock assessment of Fena Reservoir commenced in FY98 and continued in FY99. Various methods were researched and potential sites were explored. A mark-recapture method was chosen and some of the required materials were procured. The stock assessment was to have commenced in the dry season of FY99 (January - May) but was delayed because of problems with the availability of required watercraft. Methods and materials were tested in the clear water of Cocos Lagoon prior to implementation of the project in the murky waters of Fena Reservoir. The stock assessment will commence in January of FY00.
4. The development of a more extensive freshwater field guide continued in FY99. A digital camera and software were purchased for use in producing and editing photos of freshwater fauna. Photos taken by a professional photographer were reviewed and the option of commissioning professional photos is being explored.

RESULTS

Significantly fewer species per square meter were seen in all rivers in FY99 than in FY97 ($P < 0.05$; Mann-Whitney U) (no significant difference between species density in FY98 and FY99; $P > 0.05$, 1-way ANOVA). However, the number of species seen in FY99 was higher than in FY97. Eleven species were seen in surveys in FY99 (Table 1), while 8 species were seen in surveys in FY97 (8 species were also seen in FY98). Additionally, there was no significant difference between FY99 and both FY97 and FY98 for total density in all rivers ($P > 0.05$; 1-way ANOVA). The gobies *Mugilogobius cavifrons*, *Sicyopus* sp. (formerly known as *Sicyopus leprurus*), and *Sicyopterus macrostetholepis*, and the tucunare *Cichla ocellaris* were not recorded in any surveys. No single species was seen in all streams surveyed.

Table 1. Species distribution in experimental and control streams determined by visual surveys. An "x" indicates the presence of a species and an empty cell indicates its absence.

Species	Experimental Streams			Control Streams			
	Almagosa	Maulap	Sadog	Maagas	Manenggon	Pago	Ylig
<i>Anguilla marmorata</i>				x	x		
<i>Awaous guamensis</i>	x	x	x	x		x	x
<i>Caranx sexfasciatus</i>						x	
<i>Eleotris fusca</i>							x
<i>Kuhlia rupestris</i>				x	x	x	x
<i>Lutjanus argentimaculatus</i>						x	
<i>Macrobrachium lar</i>	x	x	x		x		x
<i>Oreochromis mossambicus</i>			x	x		x	
<i>Stenogobius</i> sp.						x	
<i>Stiphodon</i> sp.	x		x		x	x	x
<i>Tilapia zillii</i>			x				

Although species density did not differ significantly between experimental and control streams ($P > 0.05$; 1-way ANOVA), the total densities in experimental and control streams were significantly different ($P < 0.001$; Mann-Whitney U) (Fig. 1). The gobies *Awaous guamensis* and *Stiphodon* sp. (formerly known as *Stiphodon elegans*), the tilapia *Oreochromis mossambicus*, and the freshwater prawn *Macrobrachium lar* were seen in both control and experimental streams. Individually, densities of *A. guamensis*, *O. mossambicus* and *M. lar* did not differ significantly between experimental and control rivers ($P > 0.05$; Mann-Whitney U) but densities of *Stiphodon* sp. were significantly higher in the control streams ($P < 0.01$; Mann-Whitney U). The flagtail *Kuhlia rupestris*,

the eel *Anguilla marmorata*, the sleeper goby *Eleotris fusca*, the goby *Stenogobius* sp., two primarily marine species, the jack *Caranx sexfasciatus* and the snapper *Lutjanus argentimaculatus*, and neritid snails were present only in control streams. The tilapia *Tilapia zillii* was present only in experimental streams.

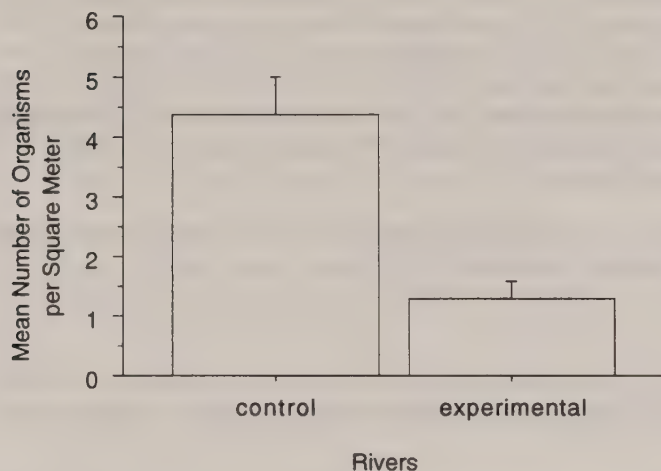


Figure 1. Mean number of organisms per square meter grouped by rivers. Densities are based on visual surveys. Experimental rivers are located above Fena Reservoir. Error bars represent standard error of the means.

DISCUSSION

Mean species density was significantly lower for all rivers combined in FY99 than in FY97, but a greater number of species were seen in FY99 than in FY97 (Table 1). Total density did not differ significantly between years. Although three years of data collection is not enough time to see broad trends, total densities and species composition appear quite consistent. Species density was significantly higher in FY97, but it has remained consistent for the past 2 years.

Densities for several species did not differ significantly between experimental and control streams. However, densities of *Stiphodon* sp. were significantly higher in control streams than in experimental streams. This also occurred in FY97 but there was no significant difference between *Stiphodon* densities in control and experimental streams in FY98. It is too soon to tell whether these data reflect general trends associated with the presence of the dam or if differences are due to natural variation.

Six species and one family of snails were seen only in control streams. The dam probably excludes flagtails because it is not morphologically adapted for climbing. It is also absent above natural waterfalls in most streams of Guam. Eels have been seen above the reservoir but not in surveyed sites. Eels and sleeper gobies were certainly under-represented in our daytime, visual surveys due to the nocturnal activity of eels and the cryptic nature of sleeper gobies. *Stenogobius* sp. is normally found in the lower reaches of streams and would not be expected to exist in the experimental streams. The two primarily marine species, the jack *Caranx sexfasciatus* and the snapper *Lutjanus argentimaculatus*, are more often encountered in the lower reaches of streams, but they have also been seen much further upstream in rivers without major barriers (i.e. large waterfalls, dams, etc.).

The snail family Neritidae has not been seen above the dam since surveys began in 1996. However, they are not prevented from scaling vertical heights anatomically. One individual was seen on the spillway in 1996 and nerites have been seen above waterfalls in other streams. Species of nerites often exhibit rheotaxis and thus may terminate their upstream migration in the absence of a perceptible current dampened by the presence of the lake (Barry Smith, personal communication). Nerite numbers may also be reduced by predation. The exposed surface of the spillway may leave the nerites more vulnerable to predation by migratory shorebirds. In FY00, a brief survey of the spillway will be conducted. The presence of adult snails or egg sacs at the upper edge of the spillway will suggest that the lack of current due to the lake may be limiting the migration of the snails further upstream. Alternatively, the presence of shell fragments on the spillway will suggest that predation may be more important.

Tilapia zillii was seen only in experimental rivers. However, it has not been restricted to areas above the dam. It was seen in control rivers in FY98.

RECOMMENDATIONS

A new 5-year plan for this project will commence in FY00. Most of the objectives remain the same, but new emphasis will be placed on increasing public interest in freshwater fisheries.

This study continues to suggest that dams and reservoirs in tropical streams may not have severe effects on most species. However, these ecosystems are complex and there can be high variability between streams and between years. Annual monitoring of these watersheds should continue in order to clarify ambiguous results seen so far.

A stock assessment will be conducted in FY00. The assessment should include the search for unknown species as well as the determination of densities of known species.

Discussion with the U.S. Navy will be required in FY00, in order to reestablish public access to fishing at Fena Reservoir.

Literature compiled for the freshwater field guide should be condensed into a practical form. Digital technology should be explored for production of the guide.

A poster showcasing the native freshwater fauna and habitats of Guam should be produced in FY00. Plans for a follow-up poster showcasing freshwater fishing on Guam should also be developed.

This project should move towards integrating freshwater monitoring with coral reef protection. This entails investigating the rate of erosion and sediment loading in our streams in order to obtain a clearer understanding of depositional rates on adjacent coral reefs. Initial efforts have begun in the Ugum Watershed through a project initiated by the Guam Water Planning Committee. Various methods of monitoring by an interagency team, including measuring turbidity and soil depositional rates, will be implemented to test the effectiveness of a tree-planting project in the watershed.

PROJECT COST

The estimated cost for this project is \$72,000.

LITERATURE CITED

- BioSystems Analysis, Inc. 1990. Natural Resources Management Plan, U.S. Naval Magazine, Guam. BioSystems Analysis, Inc., Tiburon, California. 230 pp.
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- Nelson, S.G. and L. Eldredge. 1991. Distribution and status of introduced cichlid fishes of the genera *Oreochromis* and *Tilapia* in the islands of the South Pacific and Micronesia. Asian Fisheries Science 4: 11-22.

This report was prepared by: Trina J. Leberer

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-7
SUB-PROJECT NO.: F-3
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish Resources (2710,2720)

PERIOD COVERED: October 1, 1998 to September 30, 1999

BACKGROUND

The Division of Aquatic & Wildlife Resources' (DAWR) professional Fisheries Staff devoted a significant percentage of their time and effort to technical assistance to fulfill the statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments, the Fisheries Staff's review responsibility requires a continuing commitment that could extend even beyond project completion.

The Division's Technical Assistance Program (TAP) within the Administration/Coordination Section remained unstaffed due to funding. The work has been transferred to the Agricultural Development Services (ADS) Division. ADS coordinates with fisheries on issues requiring such expertise. The professional staff within the Fishery Section provide technical support to the ADS staff, and occasionally take the lead in the review of projects involving their particular expertise, such as those that may have endangered species (sea turtles) impacts and those involving coral reefs.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish resources.

FINDINGS

Fisheries Staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Fisheries Staff members actively serve as members of the following groups:

1. Recreational Water Use Master Plan
2. Western Pacific Regional Pelagic Plan Monitoring Team
3. Western Pacific Regional Bottomfish Plan Monitoring Team

4. Western Pacific Regional Coral Reef Plan Monitoring Team
5. Federal Data Coordinating Committee
6. The Guam Coral Reef Initiative, Technical Support
7. The National Coral Reef Initiative Ecological Task Force
8. Guam Water Planning Committee
9. Aquaculture Task Force

Members of the Fisheries Section attended 87 meetings and made 42 field inspections during FY99 pertaining to the protection of Guam's natural resources. Additionally, staff have continued to actively consult with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Management Council, National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Fisheries Staff during the reporting segment. In addition to occasional interviews on radio, television, and in the newspaper, they also gave talks to a number of civic groups, and schools.

Some specific Technical Assistance activities provided by the Fisheries Section included:

1. Technical support to the Divisions ADS staff who represents the Department and the Division on the ARC, which met bi-weekly to review applications for rezoning, variances, and various types of development.
2. Offered comments and provided information to the Western Pacific Regional Fisheries Management Council (WESPAC) and the Plan Monitoring Team (PMT) on projects for bottomfish, pelagic fisheries and coral reefs. Information was provided on market sampling, and stock assessment, and from recreational and near-water commercial vessels. Staff attended 6 off-island, Council related meeting.
3. Reviewed and commented on four proposed bills that would affect fisheries.
4. Investigated one suspected fish kills in island waters during the year.
5. Responded to 51 requests for information on laws and regulations pertaining to fish, endangered species, fishing and importation of fish.
6. Made 45 presentations on fish resources to other organizations or groups during the year.
7. Provided statistical data on fisheries issues to the Bureau of Planning and Department of Commerce on a quarterly basis.

8. Reviewed and commented on 11 proposals to conduct work in streams.

RECOMMENDATIONS

To ensure that local salary funds are maintained to ADS so they can continue to support this work for the Department.

PROGRAM COST

The estimated cost of the project is \$28,000.

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-7
SUBPROJECT NO.: F-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Stock Assessment Surveys of Marine Preserves and Control Sites

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

During FY99, baseline data was collected at the Piti Bomb Holes Preserve, Achang Reef Flat Preserve and their control sites. Strip transects, 50m x 50m, were laid out on the reef flats and the fore reef slopes at each site. Transects on the reef flats were divided into the following categories: sandy bottom; seagrass beds; and coral/rubble habitats. Transects on the fore reef slopes were divided into 20, 30, 40, and 50 ft. depth habitats. Two divers, one on each side of the tape, moved along transects to record the number and sizes of important food fishes, butterflyfishes, and visually obvious fishes.

Thirty-minute interval counts were conducted on the reef flats and fore reef slopes at each site. Interval counts on the reef flats and fore reef slopes were divided into the above-mentioned habitat types.

Video transects for substrate cover were conducted on the fore reef slopes of Piti Bomb Holes Preserve and Asan control sites. Video transects on the fore reef slopes were divided into the above-mentioned habitat types.

BACKGROUND

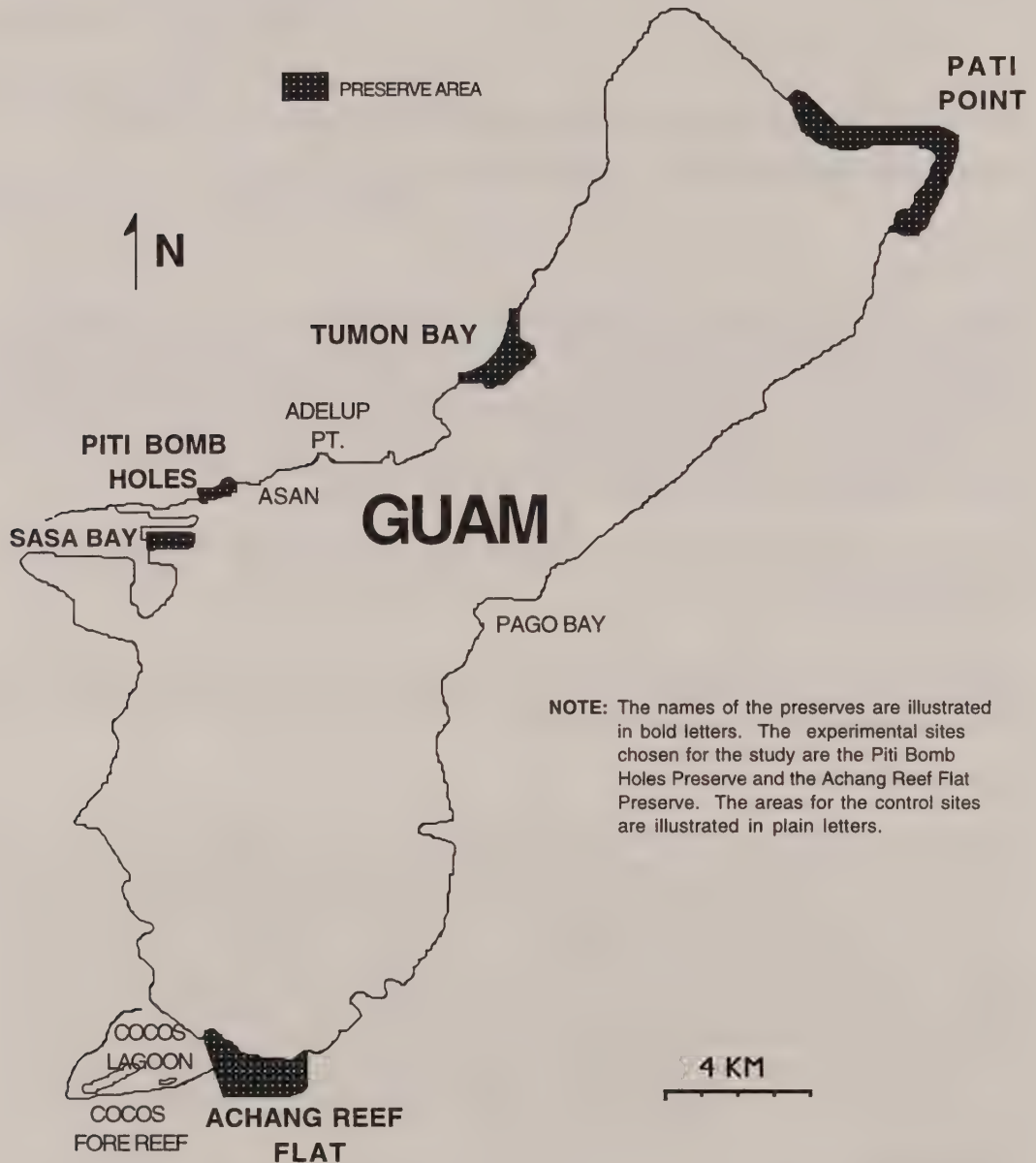
In order to restore fish stocks in the coastal areas around Guam, Public Law 24-21 was established five marine preserves and made changes to Guam's fishing regulations. The names of the preserves are listed as follows: Pati Point; Tumon Bay; the Piti Bomb Holes; Sasa Bay; and Achang Reef Flat (Figure 1). Under P. L. 24-21, the Department of Agriculture is required to monitor the areas for two years to determine the effects of the marine preserves on food fish populations and report the findings to the legislature. Stock assessment surveys of the marine preserves and control sites need to be conducted to monitor their effectiveness in the restoration of a dwindling fishery resource. Harvest and participation data obtained through the Inshore Fisheries Survey Project (F-1R, Subproject F-1, Study 1, Job 2) was used to justify the establishment of the marine preserves.

OBJECTIVE

To evaluate the effect on sport fish populations caused by the creation of marine preserves.

GOVERNMENT OF GUAM DEPARTMENT OF AGRICULTURE
DIVISION OF AQUATIC AND WILDLIFE RESOURCES

FIGURE 1. GENERAL AREAS OF EXPERIMENTAL AND CONTROL SITES



PROCEDURES

Logistics

The survey team on the reef flat consisted of 4 to 5 snorkelers/divers while the team on the fore reef slope consisted of 4 to 5 divers and a boat person. Two persons were designated to count fish (reduce bias) and one person recorded the video transects. Different counters were used at different times due to work scheduling conflicts.

Surveys required the following equipment: snorkel and SCUBA gear; a boat with safety gear; one Nikon Action 8 video camera with stingray video housing (47 in. rebar mounted on the left side); GPS; pencils with clipboards and underwater data sheets; two 50 meter measuring tapes; PVC pipes (1 in. dia. And 3 to 6 in. lengths); and PVC caps (glued to their ends and tied with nylon cords).

Site Selection

The Piti Bomb Holes and Achang Reef Flat Preserves are the experimental sites for stock assessment surveys. Cocos Lagoon is the control site for the Piti Bomb Holes reef flat and the Asan fore reef slope, which is closer to Adelupe (Figure 1), is the control site for the fore reef slope of the Piti Bomb Holes Preserve. Pago Bay reef flat is the control site for the Achang Reef Flat Preserve. During FY99, the control site for the Achang Reef Flat fore reef slope was changed to Cocos fore reef slope.

Transect Selection

Strip transects, 50 m X 5 m, were laid out on the reef flats and the fore reef slopes of each site. Eight strip transects (2 at the 20, 2 at the 30, 2 at the 40, and 2 at the 50 ft. depths) were laid out on the fore reef slopes of the Piti Bomb Holes Preserve, Asan, and Cocos. Because of poor weather conditions and lack of a boat, only four strip transects (1 at the 20, 1 at the 30, 1 at the 40, and 1 at the 50 ft. depths) were laid on the fore reef slope of the Achang Reef Flat Preserve. Eight strip transects (3 on the seagrass, 3 on the coral/algae/rubble, and 2 on the sandy bottom) were laid out on the reef flats of the Piti Bomb Holes Preserve and Cocos Lagoon. Eight strip transects (4 on the seagrass, and 4 on the coral/algae/rubble) were laid out on the reef flats of the Achang Reef Flat Preserve and Pago Bay. Also, eight strip transects were laid out near the Piti Observatory because business-feeding practices appear to be aggregating fish.

Strip Transect Technique

Two to three snorkelers/divers laid out a measuring tape to mark the length of a transect. They tied a PVC pipe to a rock at both ends of the transect to semi-permanently mark the transect. When they completed laying the transect, the fish counters, one on each side of the tape, moved along the transect recording the number and size of important food fishes, butterflyfishes, and visually obvious fishes. The transect width was estimated visually. A new transect was laid with another tape measure while the fish counters were recording fishes. The counters moved along the new transect when they completed recording fish from the previous transect. The measuring tape from the previous transect was retrieved while the counters were recording fish in the new transect, and the process continued until all transects were laid and all fish counts completed.

The transects were separated by at least 5 to 10 meters. In addition to the placement of the markers (PVC pipes), GPS coordinates were taken and maps were drawn in order to relocate the transects.

Interval (Timed-Swim) Count Technique

Interval counts, which involved counting fish for thirty minutes near the transect areas, were conducted on the reef flats and the fore reef slopes of each site. Four interval counts (2 between the 20 - 30 ft, and 2 between the 40 - 50 ft. depths) were conducted near the transects on the fore reef slopes of the Piti Bomb Holes Preserve, Asan , and Cocos. Because of poor weather conditions and lack of a boat, interval counts weren't conducted on the fore reef slope of the Achang Reef Flat Preserve. Six interval counts (2 on the seagrass, 2 on the coral/algal/rubble, and 2 on the sandy bottom) were conducted on the reef flats of the Piti Bomb Holes Preserve and Cocos Lagoon. Four interval counts (2 on the seagrass and 2 on the coral/algal/rubble) were conducted on the reef flat of the Achang Reef Flat Preserve and Cocos Lagoon.

Video Transect Technique

The method to assess the percentage of substrate cover was changed to video transects during FY99. Video transects on the fore reef slopes of the Piti Bomb Holes Preserve and Asan were conducted. Because of poor weather and lack of a boat, video transects of the fore reef slopes of the Achang Reef Flat Preserve and Cocos weren't conducted. The strip transects for the fish surveys were also used for the video transects. The procedure for recording substrate was similar to the strip transect method. Substrate was recorded from one end of the transect to the other. The rebar was used to guide the camera along the tape measure and to maintain camera and substrate distance.

RECOMMENDATIONS

- 1) If weather permits and a boat is available, obtain more baseline data on the fore reef slopes of the Achang Reef Flat Preserve and Cocos; otherwise, sufficient data has been collected.
- 2) Purchase a new boat as soon as possible for the Department of Agriculture so surveys on the forereef slope and Cocos Lagoon can be conducted. The new boat should be longer than 20 ft., able to carry six to eight passengers/divers, and capable of handling seas on the east side of the island.
- 3) Continue the temporary use of the University of Guam Marine Lab boat for the surveys, and initiate procurement of boat rental.
- 4) Investigate alternative methods besides GPS and maps to relocate transects.

PROJECT COST

The estimated cost of the "Stock Assessment Survey of Marine Preserves and Control Sites" was approximately \$70,000.

This report was prepared by: Jay T. Gutierrez.

LITERATURE CITED

Cappo, Michael and Brown, Ian W. 1996. Evaluation of sampling methods for reef fish populations of commercial and recreational interest. CRC Reef Research Tech. Rep. No. 6. 72 pp.

JOB PROJECT REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 7

JOB TITLE: Merizo Pier and Boat Ramp Facility

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

The repair of the Merizo pier and reconstruction of the boat ramp and parking facility were completed during FY99. The upgraded facility now provides the public with a new double lane boat ramp with cleated walkways, a new parking area with delineated parking stalls for both trailered and non-trailered vehicles, an access ramp connecting the parking lot to the lower portion of the facility, a designated washdown area able to accommodate two boats at one time, an upgraded electrical system and lighting on the pier, and improved bumpers on the pier. Exposure to the marine environment, vandalism, and an increase in use made it necessary to repair and upgrade the entire facility in order to continue to provide the public with safe access to boating and fishing resources.

The pier is used by recreational and subsistence fishermen who primarily do bottomfishing, castnetting, jigging, and spincasting. It is a popular fishing spot that is used at all hours by individuals, groups of individuals, and families. The location of the pier and its facilities make it an accessible, well-lit, and safe fishing area for children. The boat ramp provides access to boating and fishing resources in Cocos Lagoon, the southern coast of Guam, and several banks south of Guam. While bottomfishing, trolling, and spearfishing make up the majority of fishermen using the boat ramp, other fishing methods such as castnetting, gillnetting, night-light jigging, and the harvesting of seasonal juveniles using surround nets often use the ramp to access fishing areas by boat. In addition, small charter operations, recreational boaters, recreational SCUBA divers, and personal watercrafts use the ramp regularly.

Activity at the Merizo boat ramp and pier experienced a significant increase in recent years. The increase in fishing and boating activity damaged portions of the facility, making it necessary to do major repairs in order to provide a facility that was both safe and capable of accommodating the increased activity. Use of the pier by large commercial boats damaged several cleats, the ladders, and the upper rubber bumpers. Concrete portions of the pier bolting the upper rubber bumpers had to be repaired after a large boat collided with the pier. Several of the lights were damaged from lead weights and sinkers hitting the light post bulbs from fishermen who were bottomfishing and casting. Exposure to the marine environment undermined the single lane boat ramp, introduced marine worms, which damaged the wooden portion of the lower rubber bumpers, and increased the corrosion rate of several ladders. Also, several ladders on the pier were bent to form springboards, and several cleats were removed and replaced.

Initial plans to repair damage and to renovate the facility to accommodate the increase in use were submitted to the Department of Administration during FY95. Final engineering specifications were approved by the Department of Public Works during FY97. The contract for the project, "Upgrading of the Merizo Boat Launching Ramp Facility (Design-Build) and Repair of the Merizo Pier," was awarded to Rex International Inc. for \$678,200 in FY98. Completion of the original contract was completed during FY99.

OBJECTIVE

To repair the Merizo public pier and replace the damaged existing boat ramp facility with a new multi-lane boat launching ramp and an improved parking facility.

RESULTS

The "Notice To Proceed" to begin construction on the boat ramp and parking lot was issued by the Department of Public Works to Rex International Inc. during FY99. The damaged single lane boat ramp was demolished, removed, and replaced with a double lane boat ramp to accommodate the increase in the number of boats using the Merizo ramp. The new ramp was finished with an angled V-groove surface to allow wave and wake action to wash debris to the sides and off the ramp. The boat ramp was also constructed with a berm surrounding it to minimize undermining due to wave action. A walkway with cleats was constructed on both sides of the ramp to allow boaters to tie up to while launching and retrieving their boat.

The existing parking facility was also demolished and repaved with an asphalt concrete pavement. The new parking lot delineates parking stalls for trailered and non-trailered vehicles, and complies with ADA parking requirements. Wood pilings along the southern and western boundaries of the parking lot were removed, and a concrete retaining wall with railings was constructed on the southern boundary of the parking lot. An access ramp for persons with disabilities was constructed, providing access from the parking lot to the sidewalk constructed on the lower portion of the facility. A sidewalk was constructed on the lower portion of the facility, eliminating parking in the area and providing a walkway from the restrooms and access ramp to the boat ramp. A concrete paved rinsing station with a percolation trench was also constructed, providing boaters with freshwater for rinsing. A ribbon cutting ceremony for the upgraded facility was held on June 4, 1999 at the boat ramp facility.

RECOMMENDATIONS

Prior to the closing of the fiscal year, several enhancements were proposed to complete renovations at the facility that were overlooked in the original contract. Enhancement projects include replacing the existing ladders with more durable ones, rebuilding shoreline riprap, filling in an area of the concrete walkway leading to the pier that had undermined, adding two additional lights at the head of the ramp, and placing a vehicle barrier at the front of the pier. These renovations were proposed during FY98, but were not completed by the end of FY99 due to an excessively long review period taken by the Department of Public Works. Rather than complete these enhancement projects with the current grant, another grant is being proposed to complete these projects. These enhancement projects should provide the public with a facility capable of withstanding the current level of use and exposure to the marine environment without requiring major maintenance every year.

PROJECT COST

The estimated cost of the project is \$502,642.

Report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 2

JOB TITLE: Development of Inshore Fishing Access Facilities (2331)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Reapplication of the fishing platform project to the US Army Corps of Engineers (USACE) has been made and permit granted by them. Five sites have been prioritized within Yona and Talofoto villages to receive fishing platforms. The municipal planning council of Yona has approved fishing platform construction in their village and Talofoto village municipal planning council has not met to discuss the project.

BACKGROUND

The historical and traditional use along with design, site selection, environmental review, status of application to the Territorial Seashore Protection Commission and village public hearings have been discussed in previous fiscal year reports (Kruckenberg, 1989-1998).

OBJECTIVE

Plan, design and construct inshore fishing access facilities (reef flat platforms and cliff platforms) in coastal areas of Guam.

RESULTS

A reapplication was made to the USACE for the project because the original permit expired. All local/federal agencies have approved the project with the new USACE permit being issued. During the fiscal year, an effort was made to streamline the project to speed up its implementation. The fishing platform sites in Ylig Bay, Togcha cut, and Talofoto Bay have been prioritized to receive the fishing platforms and the other eligible sites will be reapplied for at a later date if shoreline access issues are cleared and usage of the proposed fishing platforms is positive. A municipal planning council meeting was held at the village of Yona and the project was unanimously approved there. Because of scheduling problems with the municipal planning council at Talofoto, they were not able to meet during FY99.

RECOMMENDATIONS

The Division recommends that the fishing platform program continue to improve safety and fishing opportunities for people fishing inshore areas. If approval is granted by the village of Talofoto, the project will be presented to the Territorial Seashore Protection Commission. Once they grant approval, the project will go out to bid for construction. Five sites have been prioritized to receive fishing platforms and will be constructed based on available funding.

PROGRAM COSTS

The estimated cost of the project was approximately \$262.00.
Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 10

JOB TITLE: Masso Reservoir Restoration (2322)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

The Guam Land Use Commission has approved the Wetland permit for the Masso Reservoir restoration project. In addition, the 401 Water Quality Certification was granted by the Guam Environmental Protection Agency (GEPA). Two acres of *Acacia* sp. trees have been planted on the adjacent Government of Guam property.

BACKGROUND

The project will enhance sport fishing opportunities and/or protect the freshwater finfish resources at Masso Reservoir. The history and status of the Masso Reservoir Project was outlined in previous job progress reports (Kruckenberg 1993 – 1998). The project involves dredging of the reservoir, rehabilitation of the water control gate structure, construction of a cofferdam, development of the area for public access and shoreline fishing.

OBJECTIVE

To provide a public access freshwater fishing facility at Masso Reservoir.

RESULTS

During FY99, the Guam Land Use Commission approved the Wetland Permit for this project. Later, the Section 401 Water Quality Certification was granted by the GEPA. In addition, a Wildlife Habitat Incentives Program reforestation project (10.9 acres) on the adjacent Government of Guam land was initiated with the cooperation of the Forestry Division at Department of Agriculture and the USDA-Natural Resources Conservation Service. During FY99, two acres of *Acacia* sp. were planted. Four more acres of *Acacia* sp. along with four acres of native trees will be planted during FY2000. Maintenance of the trees has been scheduled for FY 2001-2002. All federal/local permits have been completed for this project.

RECOMMENDATIONS

This program has valuable freshwater fishing potential for Guam while providing a safety factor and enhancing fishing opportunities. It is recommended that this job continue to develop a freshwater reservoir on Guam for sport fishing. The projected cost of the project will be around \$1,300,000. The project will be phased with the cofferdam constructed first due to environmental considerations for the endangered common moorhen using the reservoir. During the second phase, the reservoir will be dredged and the reservoir made fishable. The third phase would be to complete the project based on available funding. The project construction will depend on the selected company, bid prices, available funding

and governmental regulations. It is recommended that a management company be selected to insure the construction company follows standard engineering codes and construction plans accurately.

PROGRAM COSTS

The estimated cost of the Masso Reservoir restoration project was \$14,067.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 11

PROJECT TITLE: Fabrication and Deployment of Shallow Water Moorings (2331)

PERIOD COVERED: October 1, 1998 to September 30, 1999

OBJECTIVE

To develop a shallow water mooring program at popular fishing and recreational diving locations to minimize anchor damage to reef habitats.

SUMMARY

Installation of thirty-four shallow water moorings (SWMs) began on March 4, 1999 and was completed on April 9, 1999. Figure 1 provides a list of the thirty-four SWM sites and also maps their approximate locations; Table 1 lists the coordinates and depths of each site; Figures 2 - 10 provide a more detailed illustration of the location of each site. Figure 11 illustrates the design of the SWM system currently in use.

Of the three anchor types available - cemented eye-bolt, epoxied eye-bolt and Manta Ray anchor - only the cemented and epoxied eye-bolt anchors were utilized. It was anticipated that Manta Ray anchors would be necessary for the Apra Harbor, Sella Bay, Cetti Bay SWM sites, as well as other predominantly sand and mud bottom sites. However, hard limestone substrate was found at each of these sites and the decision was thus made to continue use of the eye-bolt anchors. Of the two types of eye-bolt anchors, the epoxied eye-bolt anchor was the most convenient to install given the ease in handling the epoxy and the relatively short curing time. The holding strength of all eye-bolt anchors installed were load-tested to withstand at least 2,000 pounds of vertical pull.

The DAWR SWMs are intended to accommodate a mixed usership and a wide variety of vessel lengths, ranging from subsistence fishing in a small skiff, to scuba diving from the larger 40-foot tour-boats carrying 30-50 recreational divers. However, the majority of the vessels utilizing the SWMs are expected to be in the 14 to 25-foot range. To ensure their availability and to prevent the mooring systems from being overloaded, decals have been affixed to the SWM buoys that indicate a 3-hour time limit, a maximum boat length of 50 feet, and a maximum weight of 35 gross tons.

Expansion of SWM Program

Expansion of the DAWR SWM program is likely as additional locations have already been identified and requested. Conversely, some sites may eventually be deleted from the program if they are determined to be rarely used, unnecessary, impractical or in conflict with other local, federal, military or existing commercial operations.

If the decision is made to further expand the SWM program, DAWR will be required to go through the same authorization and permitting processes for any new sites added to the program, including installation of additional systems at existing sites. However, it will



Figure 1. Shallow Water Mooring Sites

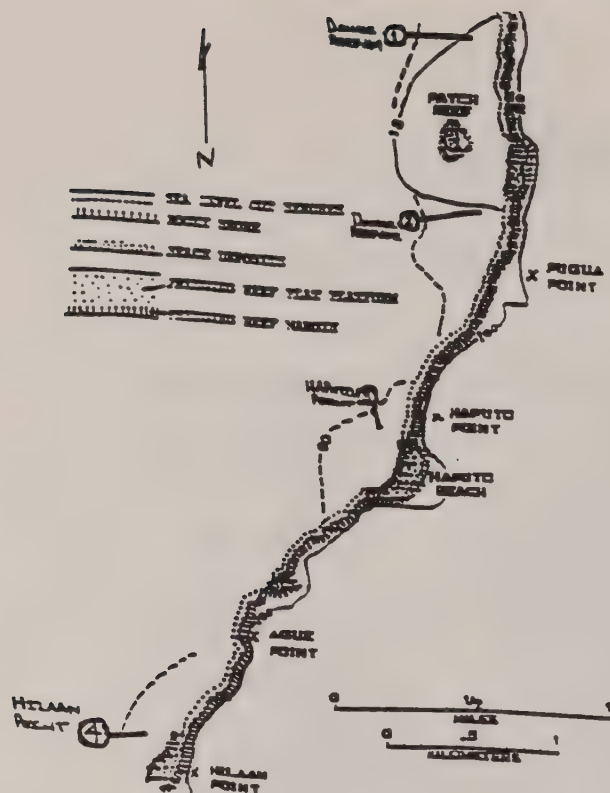


Figure 2. Sites 1-4. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

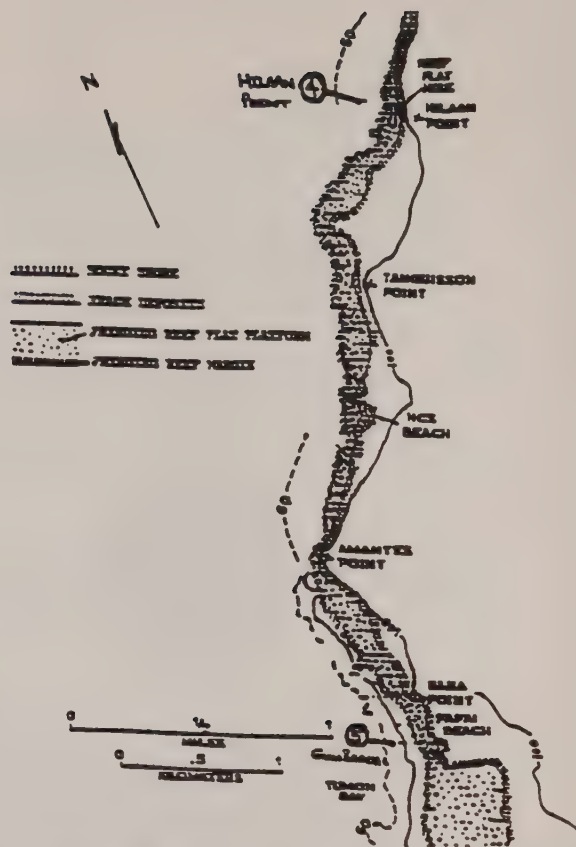


Figure 3. Sites 4-5. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

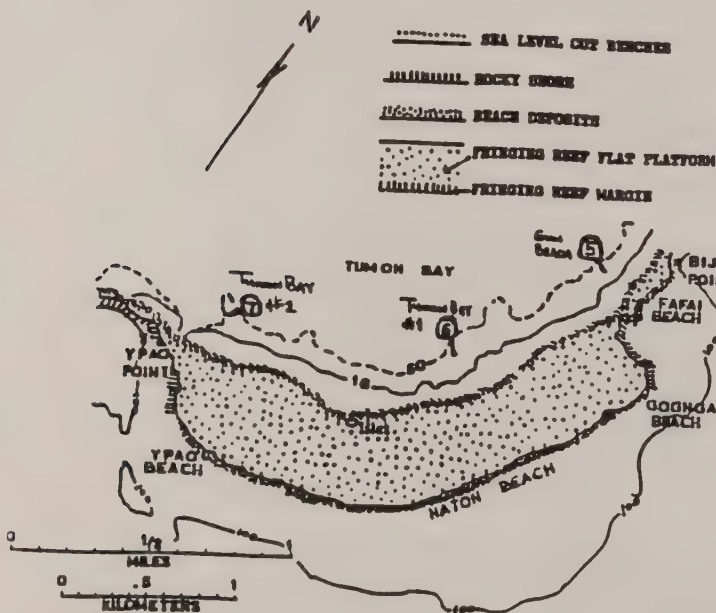


Figure 4. Sites 5-7. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 5. Sites 8-10. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 6. Sites 11-13. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 7. Sites 13-20 and A1-A5. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 8. Sites 21-26. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

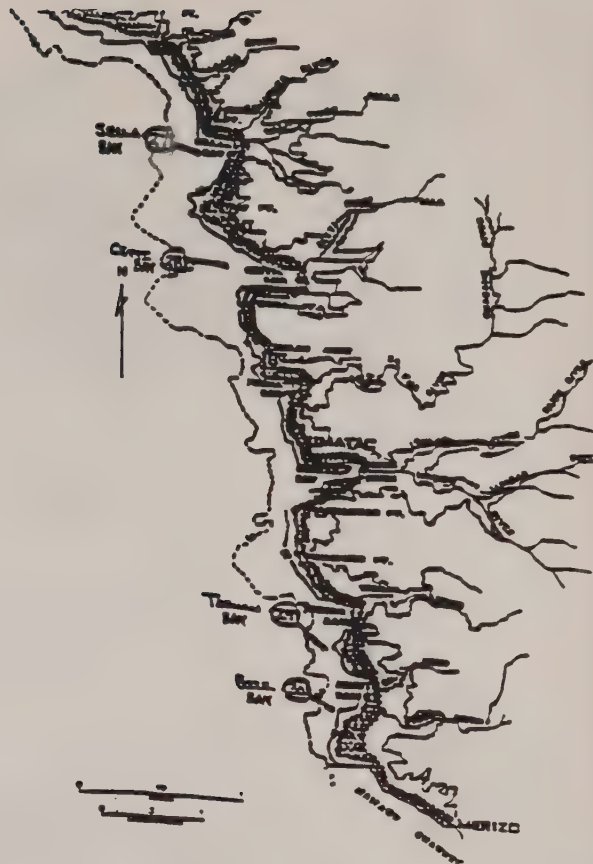


Figure 9. Sites 27-30. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

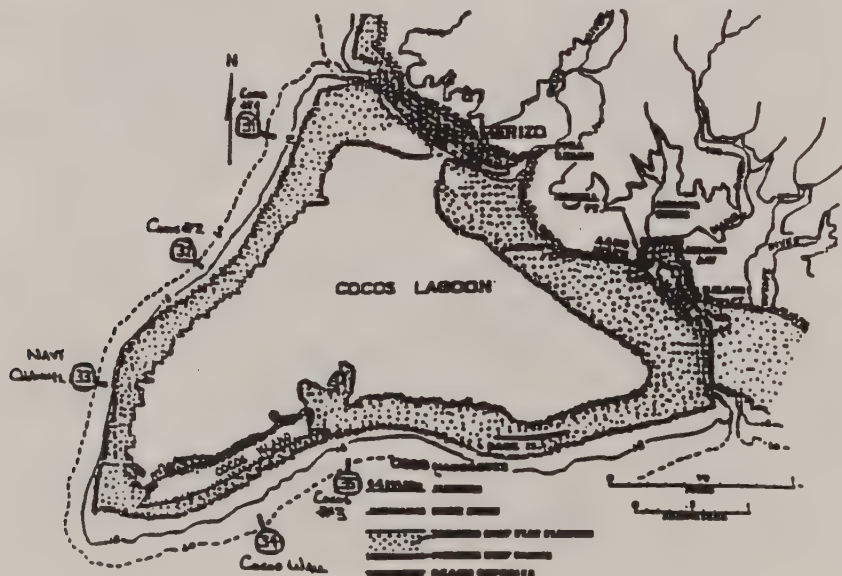


Figure 10. Sites 31-35. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

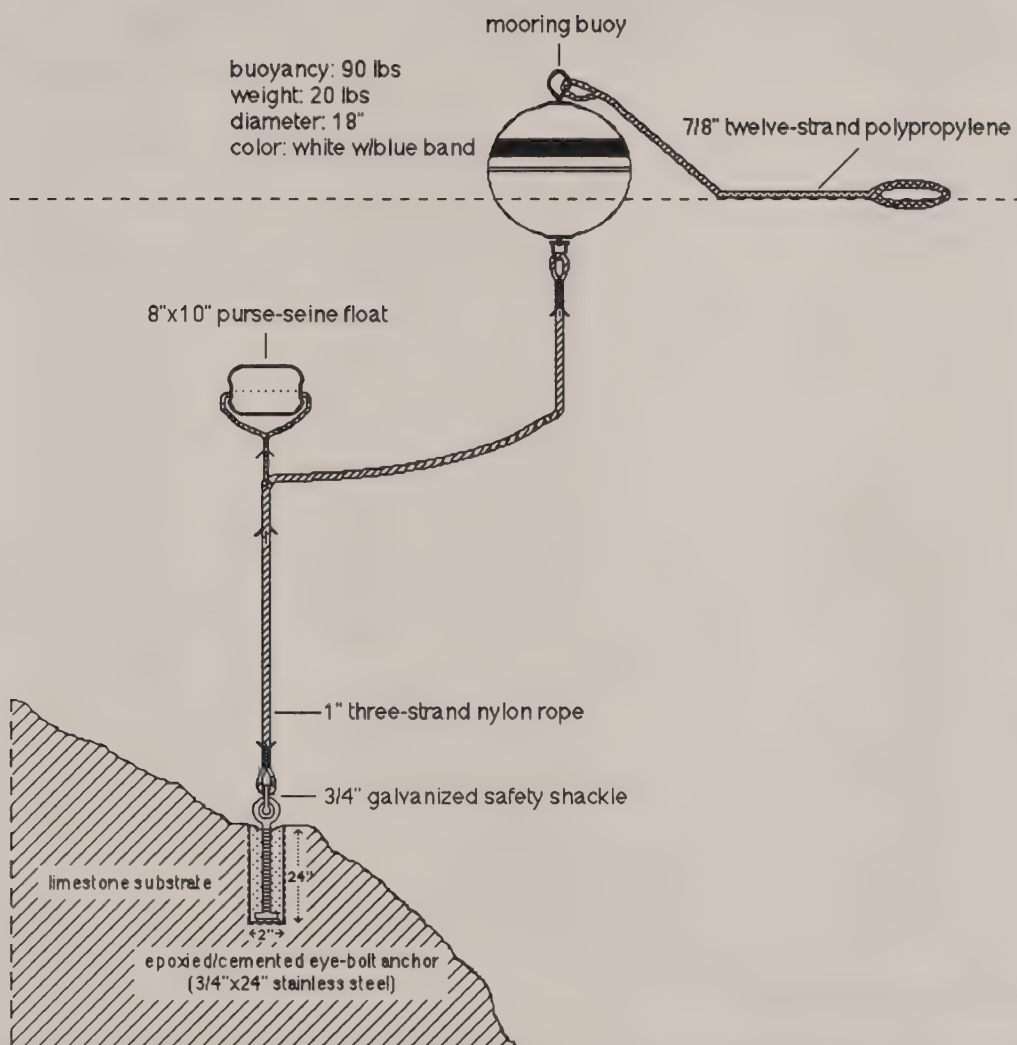


Figure 11. Shallow Water Mooring Design

likely take much less time to complete the necessary steps for a “Phase II” expansion of the DAWR SWM program.

Table 1. Shallow Water Mooring Site Coordinates and Depths.

No.	Site Name	Coordinates	Depth (ft.)
1.	Double Reef #1	13°36.219'N / 144°50.105'E	33
2.	Double Reef #2	13°35.713'N / 144°49.988'E	39
3.	Hilaan Pt.	13°33.763'N / 144°48.985'E	45
4.	Gun Beach	13°31.470'N / 144°48.068'E	20
5.	Tumon #1	13°31.032'N / 144°47.162'E	30
6.	Tumon #2	13°30.641'N / 144°47.162'E	45
7.	Alupat Island	13°21.608'N / 144°46.026'E	47
8.	East Agana	13°29.337'N / 144°45.873'E	35
9.	West Agana	13°29.046'N / 144°44.008'E	48
10.	Asan	13°28.646'N / 144°42.780'E	49
11.	Piti	13°28.602'N / 144°41.833'E	49
12.	Amphitheater	13°27.914'N / 144°40.549'E	57
13.	Luminao Reef	13°28.070'N / 144°39.366'E	45
14.	Blue Hole	13°26.177'N / 144°37.589'E	50
15.	Shark Pits	13°25.260'N / 144°38.372'E	56
16.	Rizal	13°24.666'N / 144°38.953'E	46
17.	Haps Reef	13°23.678'N / 144°39.196'E	50
18.	Alutom Island	13°23.072'N / 144°38.763'E	53
19.	Bangi Point	13°22.373'N / 144°38.528'E	50
20.	Anae Island	13°21.380'N / 144°38.240'E	20
21.	Pete's Reef	13°20.652'N / 144°38.265'E	55
22.	Sella Bay	13°19.361'N / 144°39.100'E	16
23.	Cetti Bay	13°18.932'N / 144°39.188'E	35
24.	Toguan Bay	13°17.003'N / 144°39.665'E	37
25.	Bile Bay	13°16.600'N / 144°39.700'E	48
26.	Cocos #1	13°15.900'N / 144°39.258'E	46
27.	Cocos #2	13°15.061'N / 144°38.715'E	36
28.	Navy Channel	13°14.485'N / 144°38.375'E	37
29.	Cocos Wall	13°14.250'N / 144°39.552'E	45
30.	Cocos #3	13°14.249'N / 144°40.019'E	55
31.	Jade Shoals	13°27.189'N / 144°39.720'E	45
32.	Western Shoals	13°27.020'N / 144°29.230'E	20
33.	Gab Gab #1	13°26.694'N / 144°38.729'E	20
34.	Gab Gab #2	13°26.706'N / 144°38.655'E	60

RECOMMENDATIONS

The project to develop and enhance the Guam SWM program should be continued with the following recommendation for FY00:

1. A maintenance routine for the mooring buoy program should be implemented under F-3-D-4 now that the initial installation phase has been completed. Procedures should include changing the safety shackle at the anchor pin before the nut seizes on the bolt, and replacement of any missing information decals that may have come off.
2. An evaluation of the SWM program should be conducted to determine if the location of existing sites remain satisfactory and if additional sites are

necessary. Input from the SWM usership should also be solicited and compiled to aid in planning the future course of the project.

3. Most of the hydraulic equipment purchased by DAWR for the installation of the SWM anchors was stolen in July, 1999. Rather than replacing the equipment, DAWR should consider having the contractor selected for any future installation contract furnish the necessary hydraulic equipment if the charge is reasonable.

PROGRAM COST

The estimated cost for the SWM project is \$116,436.

This Report was Prepared by: Andrew A. Torres.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-3-D
SEGMENT: 3

PROJECT TITLE: Maintenance and Redeployment of DAWR FADs and SWMs (2323)

PERIOD COVERED: October 1, 1998 to September 30, 1999

OBJECTIVES

1. To maintain, preserve and efficiently replace DAWR's fish aggregating devices.
2. To maintain, preserve and efficiently replace DAWR's shallow water moorings.

SUMMARY

FADs

The coordinates of the sixteen operational sites in the Division of Aquatic & Wildlife Resources' (DAWR) Fish Aggregating Device (FAD) program and their relative locations to the island are depicted in Figure 1. As of September 30, 1999, three FADs were confirmed to be off-station: Pati Point, Agat Bay, and Fadian Point. Figure 2 diagrams the design and construction of the FAD system presently being used at each of the sites.

Seven FADs came off station in FY99. The average lifespan was approximately 21 months, with a range from 1.5 months to 43.25 months. If the average time on station is calculated following the Hawaii FAD program practice of only including FAD lifespans that have exceeded six-months (i.e., not include the Agat Bay and Fadian Point FADs that were on station for only 2.5 and 1.5 months respectively), the FY99 FAD average lifespan would instead be just over 29 months. The argument for not including lifespans of less than six months is based on the belief that such systems were lost as the result of a faulty deployment and does not consider the possibility that the loss was the result of fishing activity or fishbite. Table 1 lists the seven FADs lost in FY99, the date deployed, when they were reported to be off-station, the recovery date and length of time on station.

Table 1. FAD Losses - FY99

Site	Date Deployed	Date Lost	Date Recovered	Time on Site
Agat Bay	07/29/98	10/13/98	not recovered	2.50 months
Fadian Point	09/04/98	10/21/98	not recovered	1.50 months
Nine-mile	08/24/95	01/15/99	not recovered	40.00 months
Uruno Point	07/13/95	02/23/99	not recovered	43.25 months
Cocos Island	09/05/97	03/21/99	not recovered	18.50 months
Pati Point	08/07/96	08/22/99	not recovered	36.50 months
Agat Bay	01/28/99	09/17/99	09/17/99	7.75 months
Average:				21 months

(Average lifespan not including losses where FAD was on station for less than 6 months: **29 months**)

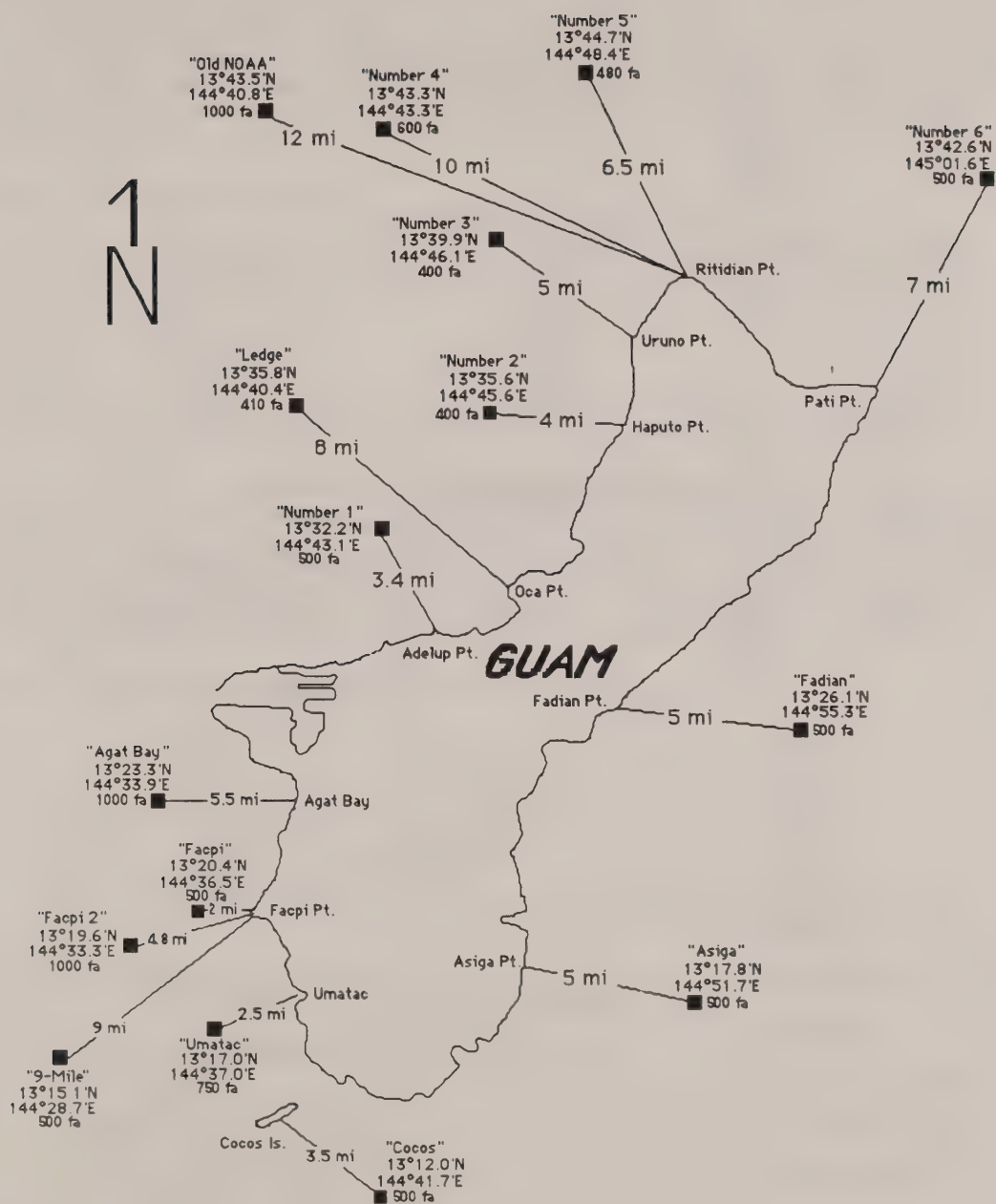


Figure 1. DAWR FAD Sites

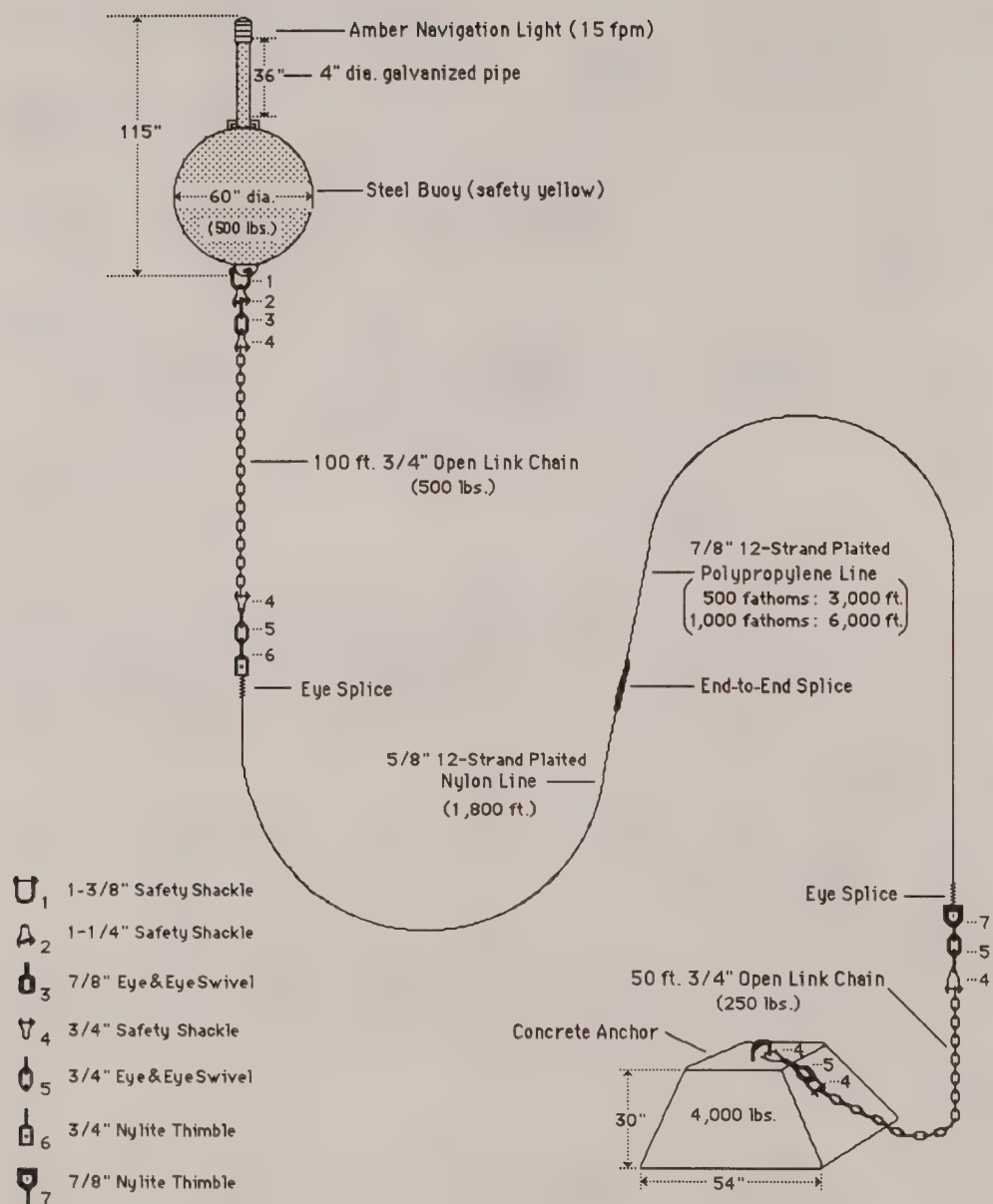


Figure 2. FAD with Spherical Steel Buoy

The average replacement period for a FAD system in FY99 was 3.4 months, with a range from 0.7 to 5.9 months. How soon a FAD can be reestablished depends primarily on prevailing sea conditions because deployments are typically conducted during calm seas to ensure the safest working conditions. Therefore, the 5.9 months that it took to replace the Uruno FAD was greatly affected by the fact that this FAD was lost during the trade-wind season when there were much fewer periods of calm seas to work with. Table 2 lists the location, redeployment dates and replacement time for the six FADs that were reestablished in FY99.

Table 2. Reestablished FADs - FY99

Site	Date Reestablished	Date Recorded Lost	Replacement Period
No. 2	01/13/99	10/26/98	2.6 months
Agat Bay	01/28/99	10/13/98	3.5 months
Facpi 2	01/29/99	09/14/98	2.5 months
Nine-Mile	02/05/99	01/15/99	0.7 months
Uruno	08/20/99	02/23/99	5.9 months
Cocos Island	08/27/99	03/21/99	5.2 months
Average:			3.4 months

The average replacement cost for a 500-fathom FAD system for FY99 was \$7,956.18; down just over \$1,000.00 from the previous year. This was the result of a majority of the replacements being located the closer to port. Table 3 lists the major costs for the replacement of a 500-fathom FAD system. A 1,000-fathom FAD system costs an extra \$1,860.00 due to the additional 3,000 feet of polypropylene rope necessary to complete the system. Table 4 provides a summary of recovery and replacement activity for FY99.

Table 3. Average Replacement Cost per 500-Fathom FAD System - FY99

Item/Service	Cost
Buoy	\$ 518.50
Buoy preparation*	\$ 494.00
Anchor block	\$ 368.96
Pre-spliced mooring system (500 fa)**	\$ 3,575.00
Solar-powered navigation light	\$ 329.72
Loading and Deployment	\$ 2,670.00
Total:	\$7,956.18

* Includes sanding, painting, welding and moving services.

** Additional \$1,860.00 for 1000-fathom system

Table 4. Operations & Maintenance Activity and Costs - FY99

Activity	Date	Cost
Recovery of No.2 FAD (Direct Payment)	10/26/98	\$1,818.00
Reestablish No.2 FAD; replace lights: No.1, Ledge	01/13/99	\$2,849.00
Reestablish Agat Bay FAD; replace light: Facpi	01/28/99	\$2,356.00
Reestablish Facpi 2 FAD; replace light: Umatac	01/29/99	\$2,332.00
Reestablish Nine-mile FAD	02/05/99	\$2,239.00
Replace lights: No.4, Old NOAA, No.5, No.6	02/23/99	\$2,064.00
Reestablish No.3 FAD; replace lights:		

Nos. 1-5, Ledge, Old NOAA	08/20/99	\$3,277.00
Reestablish Cocos FAD; replace lights:		
Agat Bay, Facpi, Facpi 2, 9-Mile, Umatac	08/27/99	\$2,968.00
Recovery of Agat FAD	09/17/99	\$1,044.00
Total:		\$20,947.00*

*Does not include personnel costs and benefits

DAWR has further streamlined the predeployment preparation of FAD systems by ordering prespliced 500- and 1000-fathom systems according to DAWR specifications. The prespliced lines add little to the total cost of the FAD system, however save considerable manpower time and further facilitate convenient short-notice replacements of lost FADs. An example of this was the replacement of the Agat FAD in July 1998 only one day after it was recovered by using a prespliced 1,000-fathom system right out of the original shipping carton. Given the continued success of this strategy, future orders of FAD lines will consist primarily of prespliced systems

In FY99 twenty solar-powered navigation lights were acquired to replace the battery-powered navigational lights used over the years. The solar-powered lights (including mounting bracket) cost approximately \$330.00, have a virtually maintenance-free operating life of 5-8 years and weigh less than 3 pounds. The battery-powered navigation lights on the other hand, cost \$258.00 for the light unit alone, \$150.00 per battery set and weigh nearly 20 pounds. With a battery set life span of between 4-6 months, the battery-powered navigation lights would cost nearly \$1,000.00 to operate over a two-year period (assuming the FAD remains on site that long), not including the additional costs of hiring a vessel and crew to transport DAWR staff out to the buoy to be serviced. If the newly-acquired solar-powered lights live up to expectations, the switch to these lights should result in significant savings in the overall maintenance costs of the DAWR FAD program.

Shallow Water Moorings (SWMs)

Installation of thirty-four SWMs was completed in April, 1999. Figure 3 depicts the approximate locations of the SWMs; Figure 4 illustrates the design of the system.

Several maintenance trips were subsequently made in August, 1999, to inspect the general condition of the first series of mooring systems installed. The primary concern at this early stage of SWM maintenance is to prevent the safety shackle nut from permanently seizing onto the bolt as normal corrosion of the threads sets in, especially in light of the fact that the anchor pin and shackle are dissimilar metals. The current strategy is to change out the safety shackles before the nut has a chance to seize. It was also observed that most of the decals on the first series of SWMs installed had apparently washed off. A potential solution to this problem is to apply a spray-on adhesive to the buoy to strengthen the adhesion of the decals to the surface of the SWM buoy.

Of the thirty-four SWMs installed in FY99, only one system was lost: the Alutom Island SWM sometime around June, 1999. The mooring line was apparently severed just below the buoy and was found resting on the seafloor still attached to the anchor pin. The parting of the buoy from the mooring line so close to the surface has led to speculation that the Alutom Island SWM was either intentionally cut or struck by a vessel. The original mooring system was eventually removed and a new system was assembled and installed in its place.



Figure 3. Shallow Water Mooring Sites

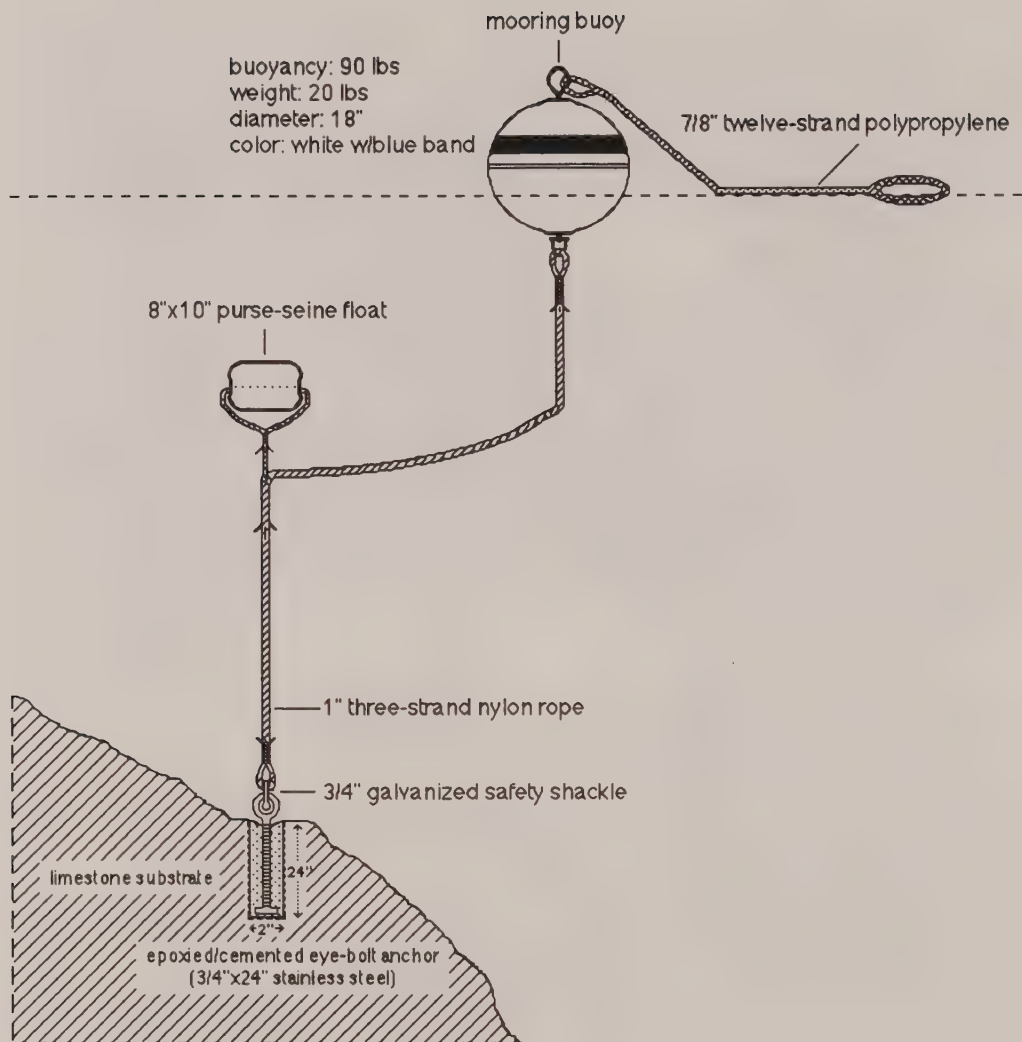


Figure 4. Shallow Water Mooring Design

RECOMMENDATIONS

The project to maintain and reinstall FADs and SWMs should be continued with the following recommendations for FY99:

1. Reestablish the open account to prepare FAD systems for deployment, conduct actual deployments, recover errant buoys, and perform on-site replacement of expired navigation lights and worn FAD buoys on an as-is-needed basis.
2. Identify and contract a private vendor to conduct SWM maintenance and reinstallation services on a short notice and as-is-needed basis similar to that of the FAD project.
3. Reorder buoys, concrete anchors, prespliced ropes, chains and other miscellaneous mooring hardware to establish an inventory sufficient to replace up to ten 500-fathom FAD systems and twenty 10-fathom SWM systems.
4. Purchase a new workboat to allow for some minor maintenance routines to be conducted for both the FAD and SWM projects.
5. Establish and maintain an inventory of other miscellaneous equipment, supplies and materials, such as navigation lights and batteries, necessary for both the FAD and SWM projects.

PROGRAM COST

The estimated cost for the project to continue maintenance and reinstallation of FADs and SWMs is \$81,337.

Prepared by Andrew A. Torres

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-4-D
SEGMENT: 1

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices (2323)

PERIOD COVERED: October 1, 1998 to September 30, 1999

OBJECTIVE

To enhance access to Guam's heavily-utilized nearshore pelagic fishing grounds through the continued development of a system of fish aggregating devices (FADs).

SUMMARY

Fish aggregating device (FAD) development activity under Project F-4-D focuses primarily on identification and survey of potential new sites including the initial deployment of FAD systems. The project also involves enhancement projects such as the production of FAD location maps for fishers and the improvement of the current FAD system design to extend the average time on station. FY99 activity under F-4-D consisted primarily of bottom contour surveys of two potential new sites: the shallow point of Rota Bank on July 15th, and Perez Bank on September 24th, 1999.

The recommendation to use the Indian Ocean "raft" as an economical, low-resistance and easily maintained alternative buoy system was tabled again in FY99 and will remain so until DAWR can obtain an Coast Guard exemption from having to install navigation lights on this particular FAD buoy design. The basis for the exemption is that the string of purse seine floats forming the raft poses little threat should a vessel collide into such a system. As depicted in Figure 2, the Indian Ocean raft system uses a flag to mark the location of the FAD. Present Coast Guard regulations requiring the installation of a navigation light would necessitate further modification of the raft to include another buoy on the terminal end of the buoy system to support a navigation light.

RECOMMENDATIONS

The F-4-D project to develop and enhance the Guam DAWR FAD program should be continued with the following recommendations for FY00:

1. Continue pursuit of program enhancement activities such as identification and permitting of potential new sites, and production of laminated FAD site maps and route planners for distribution to fishers.
2. Attach ribbons made of plastic strapping material to upper mooring chain of each FAD to further enhance bait and fish-attracting characteristics of the FADs.

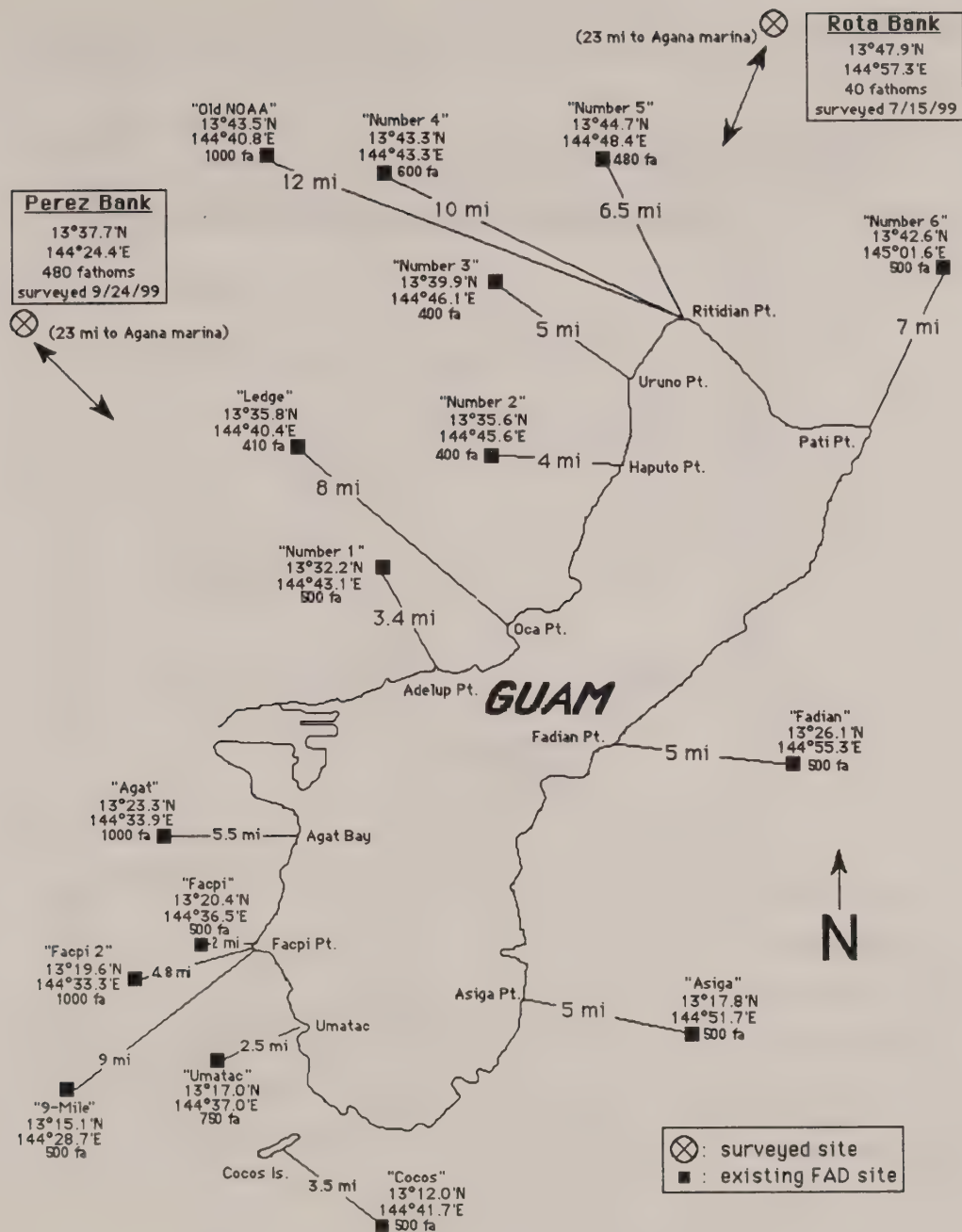


Figure 1. FAD Sites surveyed in FY99

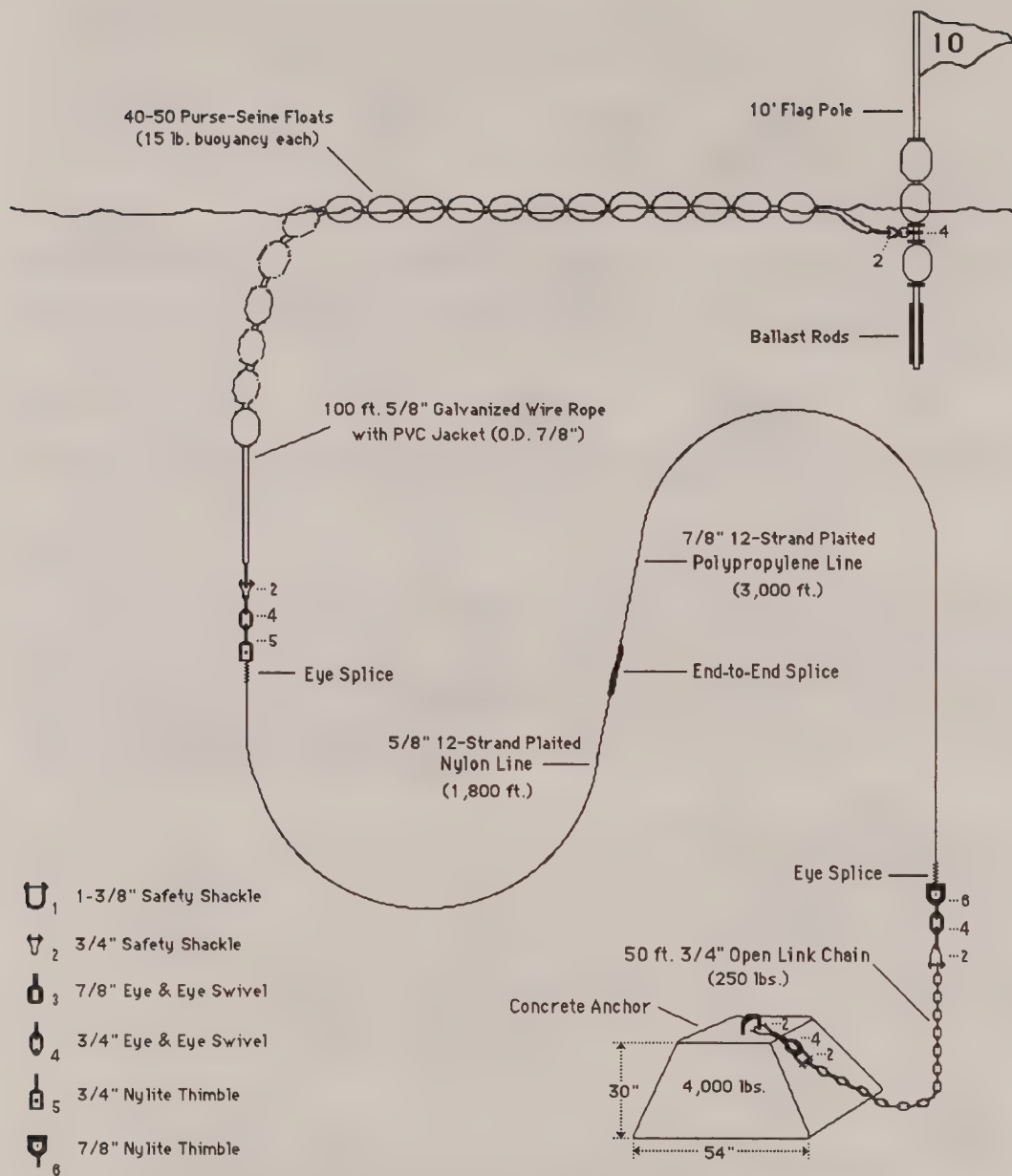


Figure 2. FAD with Indian Ocean Raft Buoy

3. Pursue exemption from Coast Guard of navigation light requirement for Indian Ocean raft buoy and then begin experimental use of this design at several sites.
4. Develop a practical form of cut protection for the upper 1,000 feet of nylon line, or incorporate a more cut-resistant line in the mooring system to replace the type of nylon line presently being used, given that most breaks continue to occur between 101 feet (where the upper mooring chain ends) down to about 750 feet.

PROGRAM COST

The FY99 estimated cost for the FAD project is \$3,045.

Prepared by Andrew A. Torres

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: CVA-1

JOB TITLE: Construction of Pumpout Facilities

PERIOD COVERED: October 1, 1998 - September 30, 1999

SUMMARY

In FY97, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) was awarded a \$107,000 three-year grant in the Clean Vessel Act Pumpout Grant Program. Under this program, DAWR is able to construct pumpout stations (POS) where necessary. The primary boat marinas for possible construction of pumpout facilities (POFs) are the Gregorio Perez Marina in Agana and the Agat Marina in Agat due to the activity generated through recreational and commercial fishing, boating, diving, sailing, and live-aboards.

In FY98, various companies specializing in POFs were contacted for information on different systems and pricing of these systems. The Port Authority of Guam (PAG) and Guam Waterworks Authority (GWA) were contacted to assist in the planning and contract phases. DAWR staff inspected the marinas to find possible locations for a stationary POS at each site.

In FY99, DAWR held meetings with PAG to secure authorization to initiate the design and installation of the POS at Hagatna and Agat. DAWR also met with GWA to determine whether the POS can be connected to the main sewer lines at both sites (Hagatna and Agat). Two Sani-Sailor POS were purchased from EMP Industries in St. Petersburg, Florida.

OBJECTIVES

1. To construct one POF at each of the following marinas, Gregorio Perez Memorial Marina in Hagatna and Agat Marina in Agat, which will provide recreational boaters with facilities to dispose of their sewage.
2. To develop a boater education program to educate boaters in the proper procedures for using the POF and increase environmental awareness of the negative aspects of direct discharge of waste into the ocean.

PROCEDURES

Meetings were held with Capital Improvement Projects (CIP) officials from the Port Authority of Guam to determine the following:

- 1) Lead agency in pumpout design and installation.
- 2) Determination of POS (stationary or mobile unit).
- 3) Possible sites for POS at both marinas.

- 4) Contact person for future meetings.

A meeting was also held with CIP officials from GWA for permission to incorporate the POS into the main sewer lines at both marinas. The Guam CVA Coordinator attended

RESULTS

Meetings with the Port Authority the Guam authorization for DAWR to design and install stationary waste POS at Gregorio Perez Memorial Marina and Agat Marina, PAG will provide layout plans for the both marinas.

PAG will maintain the POS

RECOMMENDATIONS

To expedite the construction of the POS, the following recommendations are submitted for FY00:

- 1) Initiate the bid contracts to implement the design and construction process.
- 2) Determine all necessary permits and initiate applications.

PROGRAM COST

The FY99 estimated cost for the pumpout project is \$17,509.

Report Prepared by: Veronica Cummings

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Commercial fisheries receipt books were used by five vendors during the fiscal year. The collected data was computerized and sent to NMFS in Hawaii.

BACKGROUND

The commercial fisheries program was established in 1979 to learn more about the fishery resource being caught and sold on Guam. The program was initiated by the National Marine Fisheries Service (NMFS). In the beginning, data was only collected from the Guam Fishermen's Cooperative in Agana. The program has slowly grown over time with many of the early participants no longer in business. As part of the long term program plan, data collection and management has shifted from NMFS in Hawaii to the Guam Division of Aquatic and Wildlife Resources (DAWR). Program responsibility has slowly increased to the point where DAWR now handles data collection, computer input and production of commercial landing tables. All data collected is forwarded to NMFS for further analysis by their staff for regional reports.

OBJECTIVES

To monitor, analyze and report locally caught fish sales and related activities through the collection of vendor's receipts.

PROCEDURES

The Guam Commercial Fisheries receipt books are provided to each volunteer fish vendor. When the catch is purchased, each cooperating vendor is asked to record the following information: name of the person, date, hours fished, number of fishermen, fishing location and fishing method. The assigned fisherman number is placed on each receipt after it is returned. A record is kept of all new people who sell fish and when they have consistently sold fish are given a number. The catch information is broken down into six primary areas:

- (1) Bottom fish
- (2) Reef fish
- (3) Troll (pelagic) fish
- (4) Invertebrates
- (5) Seaweed
- (6) Imported Items

Each category of organisms has an assigned code number. Although there is a category for imported fish, the program is primarily intended to monitor locally caught and sold fish. There is space provided to indicate the number of items sold, total weight, price paid per pound, the value of the items, the total value of the transaction and any additional remarks. There are three copies of each receipt with one for the person selling the catch, the vendor and one for DAWR. Vendors are visited on a regular basis to monitor completion of the forms, collect completed receipt books, to check on errors and insure they have a supply of receipt books.

RESULTS

During FY99, vendor receipt books were collected from five active cooperating vendors on a regular basis. The collected data was entered, cross-checked for accuracy and all questions about the data verified with the vendors. The data, representing the actual sold catch from the program for the fiscal year, has been transferred to the NMFS office in Hawaii for storage, inclusion in the "Fishery Statistics of the Western Pacific" and the bottom fish/pelagic plan monitoring team annual reports.

RECOMMENDATION

Develop regulations to require the person representing the catch to provide an identification number to each vendor when selling locally caught and imported fish. This would give a more comprehensive view of the commercial fishery activity around Guam.

Report Prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUBPROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer
(1460)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Official logs with deer harvest statistics for Andersen Air Force Base (AAFB) were examined and revealed a total of 3,699 hunter sorties, a harvest of 55 deer, and a harvest rate of one deer per 37.9 hunter-days. Population trend data obtained with spotlight counts at Pati Point, AAFB showed a significant decrease ($P < 0.001$) in deer numbers, with an average of 8.7 animals recorded per km during counts. The Munitions Storage Area (MSA) on AAFB experienced a similar decline ($P < 0.01$), with an average of 5.1 animals recorded per km during counts. On Naval Ordnance Annex (NOA), spotlight counts showed a non-significant decrease ($P > 0.05$) in deer numbers, with an average of 8.7 animals recorded per km during counts. Spotlight counts were expanded to include the Naval Computer and Telecommunications Area Master Station (NCTAMS). Revision of Guam's existing deer hunting regulations are ongoing in an attempt to increase deer take and reduce extensive habitat damage, especially on military lands.

BACKGROUND

The Guam deer (*Cervus mariannus*), or Philippine deer, has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1961 (DAWR 1961-1998). Preliminary information on distribution, population trends, and biology appeared in Wheeler (1979). Deer hunting statistics have been compiled annually since 1968. Guam has a split deer hunting season, running from October 1 to December 31 and from September 1-30. There is a bag limit of one antlered deer per season per license holder exclusive of any special harvest.

OBJECTIVES

To determine the current size and distribution of the deer population on Guam and to monitor population trends.

PROCEDURES

1. Conduct monthly spotlight counts on AAFB and NOA, and periodic counts elsewhere on the island.
 - a. Record number, sex, age, and group composition.
 - b. Analyze count data and compare with previous data to discern population trends.

2. Monitor hunter participation and harvest during the legal hunting season.
3. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Records of hunting activity and harvest were kept by officials at AAFB during the deer hunting season (Table 1). According to hunter logs from AAFB, 1,542.5 hunter-days (2,560 sorties; gun hunting only) were expended at Northwest Field (NWF) and resulted in the harvest of 48 deer. Hunting areas on the main portion of the base (MSA, Tarague basin, near the landfill, and areas north and east of the flightline) recorded 542.5 hunter-days (1,139 sorties; primarily bow hunting), with 7 deer harvested. Hunter logs for Andersen South were not kept this year. NCTAMS remained closed to all hunting.

Table 1. Hunter effort and deer taken on AAFB during October – December 1998 and September 1999, based on official hunter logs.

	Oct	Nov	Dec	Sep	Total
Andersen Air Force Base					
<u>Northwest Field</u> (gun hunting only)					
No. hunter sorties	632	580	656	692	2,560
No. hunter days (8 hr)	383.3	365.3	367.3	426.6	1,542.5
Deer taken	5	5	8	30	48
Days effort/take	76.7	73.1	45.9	14.22	32.1
<u>Main Base</u>					
Bowhunting					
No. hunter sorties	231	126	374	277	1,008
No. hunter days (8 hr)	94.8	61.2	177.4	136.1	469.5
Deer taken	3	0	2	1	6
Days effort/take	31.6	-	88.7	136.1	78.3
Gun hunting (log books missing for Oct.1-Nov. 21)					
No. hunter sorties		14	48	69	131
No. hunter days (8 hr)		10.9	28.7	33.4	73.0
Deer taken	-	0	1	0	1
Days effort/take		-	28.7	-	73.0
<u>TOTALS for AAFB</u>					
Gun hunting					
No. hunter sorties	632	594	704	761	2,691
No. hunter days (8 hr)	383.3	376.2	396.0	460.0	1,615.5
Deer taken	5	5	9	30	49
Days effort/take	76.7	75.2	44.0	15.3	33.0
Bowhunting					
No. hunter sorties	231	126	374	277	1,008
No. hunter days (8 hr)	94.8	61.2	177.4	136.1	469.5
Deer taken	3	0	2	1	6
Days effort/take	31.6	-	88.7	136.1	78.3

Gun hunting totals revealed 1,615.5 hunter-days (2,691 sorties) were expended, resulting in the harvest of 49 deer (33.0 hunter-days/deer). Bowhunters expended 469.5 hunter-days (1,008 sorties) to harvest 6 deer (78.3 hunter-days/deer).

Spotlight Count Trends

At Pati Point, deer numbers significantly decreased this year (Mann Whitney *U*-Test, $U' = 75$, $n_1 = 9$, $n_2 = 9$, $P < 0.001$) from those of the previous year. The average number of deer seen per count decreased from 87.3 (13.5 deer/km) in FY98 to 52.1 (8.7 deer/km) in FY99 (Table 2). The largest single nightly count at Pati Point decreased from 97 deer in FY98 to 87 deer in FY99.

Table 2. Composition of deer seen during spotlight counts at Pati Point on AAFB, FY99.

Class	----- 1998 -----			----- 1999 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck		3	3		6	1	3	3	2	1		0	22	2.4	1.7
Spike		5	0		1	1	2	3	0	3		2	17	1.9	1.6
2 pt		6	4		3	0	0	6	2	1		2	24	2.7	2.3
3 pt		5	1		1	2	6	3	5	4		1	28	3.1	2.0
4 pt		0	0		0	0	0	0	0	1		0	1	0.1	0.3
Doe		29	18		15	7	26	21	24	16		12	168	18.7	7.0
Yearling		8	6		2	2	7	8	3	4		8	48	5.3	2.6
Fawn		2	6		2	0	5	2	4	3		3	27	3.0	1.8
Unclassed deer		15	13		17	12	13	41	22	26		5	164	18.2	10.4
Total deer	nc	73	51	nc	47	25	62	87	62	59	nc	33	499	55.4	19.1
Miles traveled		4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0		4.0	36.0	4.0	0.0
Km traveled		6.4	6.4		6.4	6.4	6.4	6.4	6.4	6.4		6.4	57.6	6.4	0.0
Deer/mi		18.3	12.8		11.8	6.3	15.5	21.8	15.5	14.8		8.3	125.1	13.9	4.8
Deer/km		11.4	8.0		7.3	3.9	9.7	13.6	9.7	9.2		5.2	78.0	8.7	3.0

nc = no count was made.

Deer numbers at MSA also experienced a significant decrease this year (Mann Whitney *U*-Test, $U' = 32$, $n_1 = 5$, $n_2 = 7$, $P < 0.01$) as compared to FY98 (Table 3). The average number of deer recorded per kilometer decreased from 8.2 in FY98 to 5.1 in FY99.

Table 3. Composition of deer seen during spotlight counts in the Munitions Storage Area on AAFB, FY99.

Class	----- 1998 -----			----- 1999 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	1		2	2		3		2	2	2			14	2.0	0.6
Spike	3		2	5		2		5	1	4			22	3.1	1.6
2 pt	1		0	1		1		1	0	1			5	0.7	0.5
3 pt	7		6	4		3		2	2	6			30	4.3	2.1
4 pt	0		0	0		1		0	0	0			1	0.1	0.4
Doe	23		16	30		21		50	10	28			178	25.4	12.8
Yearling	13		8	6		7		11	8	6			59	8.4	2.6
Fawn	3		2	6		2		8	1	6			28	4.0	2.6
Unclassed deer	17		13	18		13		28	15	21			125	17.9	5.3
Total deer	68	nc	49	72	nc	53	nc	107	39	74	nc	nc	462	66.0	22.3
Miles traveled	8.1		8.0	8.0		8.0		8.0	8.0	8.0			56.1	8.0	0.0

Km traveled	13.0	12.9	12.9	12.9	12.9	12.9	12.9		90.4	12.9	0.0
Deer/mi	8.4	6.1	9.0	6.6	13.4	4.9	9.3		57.7	8.2	2.8
Deer/km	5.2	3.8	5.6	4.1	8.3	3.0	5.7		35.7	5.1	1.7

nc = no count was made

On NOA, deer numbers showed a non-significant decrease (Mann Whitney *U*-Test, $U' = 38$, $n_1 = 8$, $n_2 = 9$, $P > 0.05$) in FY99 (Table 4) from FY98. The average number of deer recorded per count dropped from 52.0 animals (2.4 deer/km) in FY98 to 50.6 animals (2.3 deer/km) in FY99 (Table 4). The largest single nightly count decreased from 110 deer in FY98 to 76 deer in FY99.

Table 4. Composition of deer seen during spotlight counts on Naval Ordnance Annex, FY99.

Class	----- 1998 -----			----- 1999 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	2	3		4	0		10	2	3	1	2		27	3.0	2.9
Spike	2	2		1	3		2	4	5	2	4		25	2.8	1.3
2 pt	0	1		0	3		7	2	0	0	1		14	1.6	2.3
3 pt	4	5		3	2		7	6	6	2	7		42	4.7	2.0
4 pt	0	1		0	0		0	0	0	0	1		2	0.2	0.4
Doe	22	24		16	28		55	25	18	15	27		230	25.6	12.0
Yearling	4	6		5	5		10	6	9	3	4		52	5.8	2.3
Fawn	4	2		3	6		4	3	5	1	3		31	3.4	1.5
Unclassed deer	18	16		24	16		15	21	26	13	13		162	18.0	4.7
Total deer	56	60	nc	56	63	nc	110	69	72	37	62	nc	585	65.0	19.6
Miles traveled	14.0	14.0		14.0	15.0		14.0	14.0	14.5	14.0	14.0		127.5	14.2	0.4
Km traveled	22.5	22.5		22.5	24.2		22.5	22.5	23.3	22.5	22.5		205.0	22.8	0.6
Deer/mi	4.0	4.3		4.0	4.2		7.9	4.9	5.0	2.6	4.4		41.3	4.6	1.4
Deer/km	2.5	2.7		2.5	2.6		4.9	3.1	3.1	2.6	2.8		26.8	3.0	0.8

nc = no count was made.

Spotlight counts at NCTAMS were initiated this year, with an average of 50.0 (6.2 deer/km) deer seen per count (Table 5). The largest single count was 79 deer.

Depredation Permits

Twenty-one animal depredation permits were issued during this fiscal year. Fifteen permits authorized deer take in agricultural areas, while two permitted take in suburban areas. Of these, 11 permits were issued to farmers registered with the Guam Department of Agriculture. Two permits were issued to golf resorts. Two permits authorized deer take on federal lands (AAFB and Guam National Wildlife Refuge). Permittees are required to submit a report of all deer taken. Two deer were killed on AAFB, while four deer were reported taken on farmlands.

Hunting Regulations

New hunting regulations allowing the take of three deer of either-sex during a six-month period per fiscal year were submitted to the Twenty-Fourth Guam Legislature for approval and will hopefully be enacted for the FY00 hunting season.

Vegetation Survey

A vegetation survey was initiated at Pati Point to investigate the impact of deer browsing on native plants in the area. Changing forest structure observed by biologists over the past decade prompted the study. Deer are thought to be primarily responsible for the degradation because pigs are somewhat scarce at Pati Point, which is dominated by karst topography. A summary of the findings will be available in FY01.

Table 5. Composition of deer seen during spotlight counts on NCTAMS, FY99.

Class	----- 1998 -----			----- 1999 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	1		0	3	4		1	2	1	3			15	1.9	1.4
Spike	2		0	1	2		3	2	2	1			13	1.6	0.9
2 pt	3		1	0	1		0	0	0	1			6	0.8	1.0
3 pt	5		0	4	2		7	4	3	5			30	3.8	2.1
4 pt	0		0	0	0		0	0	0	0			0	-	-
Doe	8		5	12	19		21	17	15	9			106	13.3	5.7
Yearling	6		2	2	4		4	4	2	2			26	3.3	1.5
Fawn	2		0	1	1		2	3	1	2			12	1.5	0.9
Unclassed deer	21		18	23	46		18	26	20	14			186	23.3	9.9
Total deer	48	nc	26	52	79	nc	56	58	44	37	nc	nc	400	50.0	15.7
Miles traveled	5.0		5.0	5.0	5.0		5.0	5.0	5.0	5.0			40.0	5.0	0.0
Km traveled	8.1		8.1	8.1	8.1		8.1	8.1	8.1	8.1			64.8	8.1	0.0
Deer/mi	9.6		5.2	10.4	15.8		11.2	11.6	8.8	7.4			80.0	10.0	3.1
Deer/km	5.9		3.2	6.4	9.8		6.9	7.2	5.4	4.6			49.4	6.2	2.0

nc = no count was made.

RECOMMENDATIONS

Continue spotlight counts at present intensity at Pati Point, MSA, NOA, and NCTAMS. Expansion of spotlight counts to other areas such as Route 17, Bubulao, and Nimitz Hill is recommended. Biological data should be collected from carcasses whenever possible. Written guidelines concerning hunter logbooks should be given to the proper military personnel to ensure complete and accurate hunter participation records on military lands. Hunting on NCTAMS should be reopened. A comprehensive investigation into the movements and habitat use of these ungulates is needed. A study to examine the impacts of deer on native ecosystems remains a high priority.

PROGRAM COST

The estimated cost of the deer population and distribution project under W-1R-7 is \$32,000.

LITERATURE CITED

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- Wheeler, M. E. 1979. The biology of the Guam deer. Div. Aquatic Wildl. Resources Tech. Rept. No. 3, Mangilao, Guam. 53 pp.

Report prepared by: Dana T. Lujan

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam (1460)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Examination of hunter logs from Andersen Air Force Base (AAFB) revealed a total of 5,104 hunter sorties, a harvest of 223 pigs, and a harvest rate of one pig per 14.5 hunter-days. Hunter harvest data were not available for other parts of Guam. Seventy-four pigs were taken throughout the island under depredation permits.

BACKGROUND

Wild pigs (*Sus scrofa*) are Guam's most important game species in terms of total numbers of animals harvested. This species has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 (Conry 1988, DAWR 1967-1998). The island's wild pig population is descended from domestic *S. scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found islandwide, but appear to be most numerous in the secondary limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many forested areas that rooting and wallowing damage is common and can be quite severe locally. Depredation on agricultural crops is also a problem, especially in southern Guam. About 20-30 animal depredation permits are issued annually to primarily control pig damage. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations allow for a year-round season with bag limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations islandwide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Monitor hunter participation and harvest during the legal hunting season.
2. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Pig Hunting Statistics

Records of hunting activity and harvest were kept by officials at AAFB during the year (Table 1). According to hunter logs, 2,007.8 hunter-days (3,491 sorties; gun hunting only) were expended at Northwest Field and resulted in the harvest of 130 pigs. Hunting areas on the main portion of the base (Munitions Storage Area, Tarague basin, and areas near the landfill and to the north and east of the flightline) recorded 811.4 hunter-days (1,643 sorties; primarily bow hunting), with 93 pigs killed. Hunter logs for Andersen South were not kept this year. NCTAMS remained closed to all hunting.

Table 1. Hunter effort and numbers of wild pigs taken on Andersen Air Force Base during FY99, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
<u>Northwest Field</u> (gun hunting only)													
No. hunter sorties	632	580	656	165	65	6	126	244	181	124	20	692	3491
No. hunter days (8 hr)	383.3	365.3	367.3	94.4	31.1	3.1	52.0	120.8	91.6	63.8	8.5	426.6	2007.8
Pigs taken	12	17	15	6	8	0	12	10	14	11	0	25	130
Days effort/take	31.9	21.5	24.5	15.7	3.9	-	4.3	12.1	6.5	5.8	-	17.1	15.4
<u>Main Base</u>													
Bowhunting													
No. hunter sorties	221	126	374	67	34	80	65	53	35	11	34	277	1377
No. hunter days (8 hr)	94.8	61.2	177.4	38.3	13.2	37.4	24.4	16.6	13.4	3.9	11.5	123.8	615.9
Pigs taken	4	2	11	2	3	5	3	3	2	0	2	12	49
Days effort/take	23.7	30.6	16.1	19.2	4.4	7.5	8.1	5.5	6.7	-	5.8	10.3	12.6
Gunhunting (log books missing for Oct. 1-Nov. 21)													
No. hunter sorties		14	48	10	25	52	12	28	1	0	7	69	266
No. hunter days (8 hr)		87.5	28.7	4.5	9.5	23.9	3.7	1.5	0.3	-	2.5	33.4	195.5
Pigs taken		1	9	0	9	8	3	3	0	-	3	8	44
Days effort/take		87.5	3.2	-	1.1	3.0	1.2	0.5	-	-	0.8	4.2	4.4
<u>TOTALS</u>													
Gunhunting													
No. hunter sorties	632	594	704	175	90	58	138	272	182	124	27	761	3727
No. hunter days (8 hr)	383.3	452.8	396.0	98.9	40.6	27.0	55.7	34.0	22.8	63.8	3.4	95.1	2623.7
Pigs taken	12	18	24	6	17	8	15	13	14	11	3	33	174
Days effort/take	31.9	25.2	16.5	16.5	2.4	3.4	3.7	2.6	1.6	5.8	1.1	2.9	15.1
Bowhunting													
No. hunter sorties	221	126	374	67	34	80	65	53	35	11	34	277	1377
No. hunter days (8 hr)	94.8	61.2	177.4	38.3	13.2	37.4	24.4	16.6	13.4	3.9	11.5	123.8	615.9
Pigs taken	4	2	11	2	3	5	3	3	2	0	2	12	49
Days effort/take	23.7	30.6	16.1	19.2	4.4	7.5	8.1	5.5	6.7	-	5.8	10.3	12.6

Depredation Permits

Twenty-one animal depredation permits were issued in FY99. Fifteen permits authorized pig take in agricultural areas, while two permitted take in suburban areas. Of these, 11

permits were issued to farmers registered with the Guam Department of Agriculture. Two permits were issued to golf resorts. Two permits authorized pig take on federal lands (AAFB and Guam National Wildlife Refuge). Permittees are required to submit a report of all pigs taken. Thirty-six pigs were killed on federal lands, while 38 were reported taken on farmlands. The golf resorts reported no pigs taken (extensive controlling was not initiated by one permittee).

Hunting Regulations

The proposed hunting regulations, including the unlimited year-round take of pigs, were submitted to the Twenty-Fourth Guam Legislature for approval and will hopefully be enacted for the FY00 hunting season.

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Hunting at NCTAMS should be reopened. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases is recommended. An increase in the hunter harvest of pigs is needed islandwide.

PROGRAM COST

The estimated cost of the wild pig project under W-1R-7 is \$37,000.

LITERATURE CITED

Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dept. Agric., Mangilao. 60 pp.

Division of Aquatic and Wildlife Resources. 1967-1998. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.

Report prepared by: Dana T. Lujan

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves
(1460, 1430)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

This year's Spring Bird Surveys showed an overall decrease in Philippine turtle-dove (*Streptopelia bitorquata*) numbers over last year's counts. The Cross Island Road, Reserve Craft Beach Road, and MSA routes had averages of ≥ 1.0 bird recorded per station. Eleven routes recorded decreases in dove abundance, 6 had increases, and 6 had no change in bird numbers per station count, as compared to last year's counts.

BACKGROUND

The Philippine turtle-dove was introduced to Guam in about 1771 by the Spanish during their colonization of the island (Baker 1951), and has been regulated as a game bird since at least 1903 (Conry 1987). Turtle-doves were abundant in northern and southern Guam up through the early 1960s. Population abundance began to decline in southern and central Guam in the mid to late 1960s and has since stabilized at low to moderate levels. Populations in northern Guam decreased to similar levels in the late 1970s and early 1980s. Turtle-doves remain common on snake-free Cocos Island. Predation by brown tree snakes (*Boiga irregularis*) is the major cause of nest loss in turtle doves (Conry 1988) and this introduced pest is responsible for the species' decline. Because of the decrease in numbers and poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season in March 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.
2. To investigate nesting success and causes of nest failures.

PROCEDURES

Philippine turtle-doves were surveyed during spring bird counts conducted on 23 routes throughout the island in May. These surveys consisted of 5-minute station counts at up to 10 stations per route, with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds detected per station.

RESULTS

Spring Bird Surveys

Philippine turtle-doves were recorded on 16 of 23 (70%) spring bird surveys conducted this year (Table 1).

Table 1. Numbers of Philippine turtle-doves recorded per count and average number of birds per station as detected in spring bird surveys at various locations on Guam in May 1999. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1999 Ave./Station	1998 Ave./Station	Trend in Ave 99-98
North Surveys					
Tarague	10	1	0.10	0.10	0.00
MSA	10	10	1.00	1.80	-0.80
NWF	10	2	0.20	1.10	-0.90
NCTAMS	10	4	0.40	0.10	0.30
Capitol Improvement Road	10	0	0.00	0.00	0.00
Mt. Santa Rosa	10	8	0.80	0.70	0.10
Y-Sengsong Road	10	0	0.00	0.00	0.00
Two Lover's Point	10	0	0.00	0.00	0.00
Andersen South	10	0	0.00	1.00	-1.00
Navy Golf Course	10	4	0.40	0.20	0.20
Barrigada Hill	10	3	0.30	0.00	0.30
Toto Pipeline	8	6	0.75	0.50	0.25
South Surveys					
Nimitz Hill	10	0	0.00	0.10	-0.10
Reserve Craft Beach Road	4	7	1.75	2.50	-0.75
Orote Point	6	1	0.17	2.20	-2.03
Pulantat	10	3	0.30	0.60	-0.30
Cross Island Road	10	10	1.00	0.00	1.00
Ordnance Annex	10	5	0.50	0.50	0.00
Umatac	10	0	0.00	0.00	0.00
Dandan	7	1	0.14	1.00	-0.86
Ija	8	4	0.50	1.00	-0.50
Merizo	4	0	0.00	0.38	-0.38
Cocos Island	10	9	0.90	2.60	-1.70

Cross Island Road, Reserve Craft Beach Road, and the Munitions Storage Area (MSA), had the highest counts, with averages of ≥ 1.0 birds detected per station. Cocos Island, which usually has the highest average count per station, recorded a 35% decline in total dove numbers since last year (DAWR 1998). The Dandan route was reduced from 10 to 7 stations in FY '99 due to the closure of off-road trails. Only 0.14 birds were recorded per station on this route, as compared to 1.00 birds per station last year. Of the 23 routes

surveyed in 1999, 11 (48%) had decreases in dove numbers, 6 (26%) showed increases, and 6 (26%) had no change in the numbers of birds detected, as compared to FY '98 (DAWR 1998). Three of the 23 routes recorded decreases of ≥ 1.0 birds per station.

RECOMMENDATIONS

1. Continue spring bird surveys across Guam to monitor distribution, relative abundance, and population trends of the Philippine turtle-dove.
2. Keep Philippine turtle-dove hunting season closed until nesting success improves and the population recovers.

PROGRAM COST

The estimated cost of the Philippine turtle-dove project under W-1R-7 is \$15,000.

LITERATURE CITED

- Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Publ. 3:1-359.
- Conry, P.J. 1987. Ecology of the Philippine turtle-dove on Guam. Tech. Rept. No. 6., Div. Aquatic and Wildl. Res., Dept. Agric., Mangilao.
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- Division of Aquatic and Wildlife Resources. 1988. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic and Wildl. Res., Dept. Agric., Mangilao.

Report prepared by: Lloyd B. Dicke and Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Black Francolin on Guam (1460, 1430)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Black francolins (*Fancolinus francolinus*) were detected on 19 of 23 (83%) survey routes conducted throughout Guam. Six routes had decreases, eleven routes had increases including four routes with increases of 1 or more birds, and six routes had no change in the number of francolin recorded.

BACKGROUND

In 1961, 171 black francolin were introduced to southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a 1-month season in December 1981 with a 4-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a 2-month split season, one month in January and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90, extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons.

OBJECTIVES

To determine current relative abundance and current distribution of black francolin on Guam and monitor population trends.

PROCEDURES

Conduct annual island-wide spring bird surveys (five-minute station counts) to monitor distribution and status of francolin throughout the island.

RESULTS

Spring Bird Surveys

Black francolins were detected on 19 of 23 (83%) spring bird surveys conducted in May (Table 1). Six survey routes had decreases, 11 routes had increases of which four had increases of one or more birds, and 6 routes had no change in the number of birds per

count. Francolins were found on 8 of 12 routes in northern Guam, an increase of one route from FY98 (DAWR 1998). They were found on 9 of 11 surveys south of Route 4, which was no change from last year.

Table 1. Numbers of black francolin detected per count and average numbers of birds detected per station, as detected in spring bird surveys at various locations on Guam during May 1999. Values in the trend column are the difference between the average station count between years. (Ave. = average)

Survey Location	No. of Stations	No. Birds Observed	1998 Ave./Station	1999 Ave./Station	Trend in Average 99-98
NORTHERN					
Tarague	10	0	0.00	0.00	0.00
MSA	10	11	0.02	1.10	1.08
NWF	10	14	0.10	1.40	1.30
NCTAMS	10	19	0.50	1.90	1.40
Capital Improvement Road	10	0	0.00	0.00	0.00
MT. Santa Rosa	10	2	0.30	0.20	-0.10
Y Sengsong Road	10	0	0.00	0.00	0.00
Two Lovers	10	27	1.70	2.70	1.00
Andersen South	10	3	0.50	0.30	-0.20
Navy Golf Course	10	33	3.00	3.30	0.30
Barrigada Hill	10	30	1.60	3.00	1.40
Toto Pipeline	8	0	0.25	0.00	-0.25
SOUTHERN					
Nimitz Hill	10	45	4.00	4.50	0.50
Reserve Craft Beach Raod	4	0	0.00	0.00	0.00
Orote Point	6	16	4.33	2.67	-1.66
Pulantat	10	29	2.60	2.90	0.30
Cross Island Road	10	30	4.00	3.00	-1.00
Ordnance Annex	10	53	3.50	5.30	1.80
Umatac	10	36	3.40	3.60	0.20
Dandan	7	35	4.80	5.00	0.20
Ija	8	45	6.38	5.63	-0.76
Merzio	4	22	4.25	5.50	1.25
Cocos Island	10	0	0.00	0.00	0.00

The results from all survey routes combined showed an increase in francolin numbers observed as compared to FY98. Two southern routes, Ija (5.63 birds per station) and Ordnance Annex (5.30 birds per station), recorded the highest number of birds per station for the entire island (Table 1). The Navy Golf Course route recorded the largest number of birds per station (5.00 birds per station) for northern Guam.

Francolins became noticeably more common on parts of Andersen Air Force Base during FY99, especially at Pati Point and in the Munitions Storage Area, where they were recorded for the first time.

Depredation Permits

In southern Guam, the abundance of black francolins has lead to the issuance of depredation permits to control the numbers of birds near cultivated areas to reduce crop damage. Francolins are known to peck at fruits, such as watermelon, to obtain moisture, which renders the fruit unmarketable. Under these permits, 23 males and 15 females were killed by farmers.

RECOMMENDATIONS

Continue to monitor francolin population status, distribution, and hunter harvest.

PROGRAM COST

The estimated cost of the black francolin project under W-1R-7 is \$15,000.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1998. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic Wildlife Res., Dept. Agric., Mangilao.

Report prepared by: Lamont Henderson and Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUBPROJECT NO.: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Monitor Population Size and Distribution of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Counts of feral water buffalo at Naval Ordnance Annex (NOA) showed no significant changes ($P > 0.10$) in the number of animals recorded per km during FY99.

BACKGROUND

Asiatic water buffalo (*Bubalus bubalis*) were introduced to Guam in the 1600s from the Philippines for use as beasts of burden (Wiles 1990). A population of about 2,000 water buffalo inhabited Guam prior to World War II. Many of these animals, known locally as carabao, were apparently let loose during the Japanese occupation, resulting in the creation of feral herds in the interior region of south-central Guam. The Division of Aquatic and Wildlife Resources (DAWR) began conducting spotlight counts of carabao on Naval Ordnance Annex in 1966 in conjunction with Philippine deer (*Cervus mariannus*) surveys (Wiles 1990). DAWR staff recorded an average of 0.6-0.8 animals/km on NOA between 1966 and 1978 (Anderson 1980). Carabao numbers fluctuated thereafter, with a peak in 1996 when an average of 2.8 animals/km traveled was recorded (DAWR 1980-1998). Biosystems Analysis Inc. (1989) estimated the buffalo population on NOA to be 75-150 animals in 1987. More recently, 200-300 animals have been estimated to be present (Walker et al. 1996, Lujan and Wiles 1997). Illegal hunting has been a major cause of mortality in the population (Conry 1988), but expanded anti-poaching efforts on NOA by DAWR conservation officers and the Navy since the 1980s may be responsible for allowing the population to show steady growth. High buffalo densities have resulted in localized habitat damage on the base (Conry 1988, Biosystems Analysis Inc. 1989).

OBJECTIVES

To monitor the status of the feral Asiatic water buffalo on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.

PROCEDURES

1. Conduct monthly spotlight counts on NOA. Analyze count data and compare with past data to estimate population trends.
2. Monitor carabao movements on NOA and adjacent lands along Routes 17 and 5.

3. Monitor calving by female carabao treated with the porcine zona pellucida (PZP) vaccine.

RESULTS

Spotlight Count Trends

Nine counts were made on NOA in FY99. The number of water buffalo seen per kilometer showed no change (Mann-Whitney *U*-Test, $U = 38$, $P > 0.10$) from last year, with an average of 2.3 animals/km seen this year (Table 1; DAWR 1998). A mean of 50.6 animals was recorded per count this year. The largest number of buffalo recorded on a monthly count decreased from 92 animals in FY98 to 76 animals in FY99.

Table 1. Results of monthly spotlight counts of feral water buffalo at Naval Ordnance Annex, FY99.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	76	22.5	3.8	14.0	5.4
Nov	56	22.5	2.5	14.0	4.0
Jan	61	22.5	2.7	14.0	4.4
Feb	39	24.2	1.6	15.0	2.6
Apr	45	22.5	2.0	14.0	3.2
May	22	22.5	0.9	14.0	1.6
Jun	41	23.3	1.8	14.5	2.8
Jul	52	22.5	2.3	14.0	3.7
Aug	63	22.5	2.8	14.0	4.5
Total	455	-	20.4	-	35.2
Ave	50.6	22.8	2.3	14.2	3.6
SD	15.9	0.6	0.8	0.4	1.2

Immunocontraception of Water Buffalo

A survey of treated animals in March-April 1999 revealed that at least 4 females were nursing calves. Only 14 of the 19 treated females were located. After further investigation, it was concluded that 2 females were pregnant at the time of the initial inoculations. The remaining 2 females with calves were considered contraceptive failures. Therefore, the vaccine had an 85.7% success rate. Most species treated with this vaccine have had a 90% success rate of inhibiting pregnancy (J. Kirkpatrick, pers. comm.).

After consulting with J. Kirkpatrick, it was concluded that PZP vaccine could successfully be used as a long-term management tool to control water buffalo populations. Preliminary discussions with the Navy and U.S. Fish and Wildlife Service were held in September concerning the implementation of a long-term control plan. A plan should be finalized by FY00.

Other Activities

Early-morning roadside sightings of water buffalo on Route 17 in FY98 prompted an investigation into the movements of these animals in the area. One herd of 18-20 animals used the jeep trail on Firebreak 3 to travel back and forth between Group 14 on NOA and the Tarzan Falls area north of Route 17. Carabao dung and tracks indicated another herd was accessing Route 17 from Firebreak 4. Residents and farmers in the area are convinced that these animals venture off NOA through the firebreaks and continue to travel east along

Route 17. Interestingly, many felt that these movements only occur during the dry season. Further investigations must be conducted to corroborate these movements.

RECOMMENDATIONS

Continue spotlight counts on NOA. Collect data concerning the movements of these animals, especially along Routes 17 and 5.

PROGRAM COST

The estimated cost of the wild Asiatic water buffalo project under W-1 R-7 is \$4,000.

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Report prepared by: Dana T. Lujan

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUBPROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds in the Mariana Islands

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Eleven species of resident birds were detected on spring bird counts made throughout the island. Censuses of Guam swiftlets (*Aerodramus bartschi*) at Mahlac Cave indicated that the population has increased to about 500-550 birds this year. Trapping for brown tree snakes (*Boiga irregularis*) was conducted at the cave from March to September, with 44 animals caught, including three containing swiftlet feathers in their alimentary tracts.

BACKGROUND

Predation by brown tree snakes is the major factor in the decline of most of Guam's native bird species during the last few decades (Savidge 1987, Conry 1988, Engbring and Fritts 1988). Census data from a variety of sources have documented the extirpations of eight species, while four others have undergone severe population decreases, both in terms of overall numbers and geographic range (Division of Aquatic and Wildlife Resources [DAWR] 1963-1998, Engbring and Ramsey 1984, Wiles et al. 1995).

Common moorhens (*Gallinula chloropus guami*) continue to be scattered throughout the southern and central parts of Guam, with recent population estimates placed at 100-125 birds (Stinson et al. 1991, Ritter 1997). Guam swiftlets occur primarily in one large colony on Naval Ordnance Annex (formerly Naval Magazine). Three much smaller colonies are also known and occur on the Ordnance Annex, in the Lumuna district of Yigo, and in the vicinity of the Mt. Sasalaguan in Merizo (DAWR 1987-1998, Wiles et al. 1995). Two small populations of Micronesian starlings also persist on the island, with most birds remaining on AAFB and Yigo, while smaller numbers occur on Cocos Island (DAWR 1991-1998, Wiles et al. 1995). Recovery plans have been written for each of these species except the starling (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b). In addition, the island continues to retain small to moderate numbers of several other resident bird species, as well as migratory shorebirds, seabirds, and waterfowl (Stinson et al. 1997a, b).

OBJECTIVES

To continue status surveys and natural history studies as called for in the recovery plans for Guam's endangered native birds (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b).

PROCEDURES

1. Spring bird counts were conducted on 23 routes throughout Guam during June. Locations of survey route are presented in DAWR (1987). These surveys consisted

of 5-minute station counts at up to 10 stations per route with the numbers of birds seen or heard recorded per species at each station.

2. Monthly visits to Mahlac Cave on Ordnance Annex were made to monitor the Guam swiftlet colony. When counts were conducted, observers sat at both entrances of the cave for a period of 1-2 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. During all visits, observers entered the cave for about 1 hr (prior to any counts) to record numbers of nestlings. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by using a mirror to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen in the guano from nests overhead.

RESULTS

Roadside and Spring Bird Counts

Roadside bird counts were discontinued this year. Results from this year's spring bird counts are presented in Table 1, with 11 species recorded. Data for three species are omitted from Table 1 because of space considerations. Results for these birds were as follows: Brown Noddies, 2.6 birds per station on the Cocos Island route; Black Noddies, 1.7 birds per station on the Cocos Island route; and Mariana Crows, 0.1 birds per station on the MSA route.

Table 1. Mean numbers of birds recorded per station along surveys routes in northern and southern Guam. Abbreviations are YEBI - yellow bittern, BLFR - black francolin, BBQU - blue-breasted quail, FATE - fairy tern; PTDO - Philippine turtle-dove, BLDR - black drongo, MIST - Micronesian starling, ETSP - Eurasian tree sparrow. Black francolin and Philippine turtle-doves are also discussed in their respective reports. Data for three species are omitted from Table 1 because of space considerations. Results for these birds were as follows: Brown Noddies, 2.6 birds per station on the Cocos Island route; Black Noddies, 1.7 birds per station on the Cocos Island route; and Mariana Crows, 0.1 birds per station on the MSA (formerly CWA) route.

Survey	Location	No. Stations	YEBI	BLFR	BBQU	FATE	PTDO	BLDR	MIST	ETSP
Northern Surveys										
Tarague		10	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
MSA		10	0.0	1.0	0.0	0.0	1.0	0.1	0.0	0.0
NWF		10	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.4
NCTAMS		10	0.0	1.9	0.0	0.0	0.4	0.0	0.0	0.6
Capitol Improvemt Rd		10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Mt. Santa Rosa		10	0.0	0.2	0.0	0.0	0.9	1.1	0.6	4.9
Y-Sengsong Road		10	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Two Lover's Point		10	0.5	2.7	0.0	0.0	0.0	0.0	0.0	3.4
Andersen South		10	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.7
Navy Golf Course, Barrigada		10	0.1	3.8	0.0	0.0	0.4	0.0	0.0	1.6
Barrigada Hill		10	0.8	3.0	0.0	0.0	0.3	0.2	0.0	2.2
Toto Pipeline		7	0.9	0.0	0.0	0.0	0.9	0.0	0.0	4.3

Southern Surveys

Nimitz Hill	10	0.3	4.5	0.5	0.0	0.0	0.0	0.0	0.8
Reserv Craft Beach Rd	4	0.5	0.0	0.0	0.0	1.8	0.0	0.0	2.0
Orote Point	6	0.3	2.7	0.0	0.0	0.2	1.0	0.0	1.0
Pulantat	10	0.0	2.9	0.2	0.0	0.3	0.0	0.0	2.5
Cross Island Road	10	0.1	3.0	0.0	0.0	1.0	0.0	0.0	3.9
Ordnance Annex	10	0.0	5.3	0.0	0.0	0.5	0.0	0.0	0.2
Umatac	10	0.2	3.6	0.0	0.0	0.0	0.0	0.0	0.7
Dandan	8	0.1	3.8	0.4	0.0	0.1	0.0	0.0	4.0
Ija	8	0.0	4.5	0.3	0.0	0.4	0.0	0.0	1.2
Merizo	4	0.3	5.5	0.5	0.0	0.0	0.0	0.0	1.8
Cocos Island	10	0.0	0.0	0.0	8.4	1.5	0.0	2.8	2.8

Common Moorhens

Moorhen records of special interest during FY99 are listed here: 1) A dead adult moorhen was found in the early morning at a private residence on Sgt. R. Mendiola Street in Lalo, Barrigada. The bird had perhaps flown into the side of a building. The person who found the bird showed DAWR staff a nearby pond on Limtiaco Street that has held water for many years and been occasionally used by moorhens. This site was not previously known to the DAWR. 2) Up to eight moorhens, including several immatures, were observed at the large open pond on the north side of the Guam International Airport terminal throughout the year. 3) Vegetation appropriate for moorhens regrew at the Barrigada ponding basin and a single bird was observed there on occasion. However, reestablishment of breeding has not yet been documented at this location.

Native Doves

No confirmed reports of White-throated Ground-Doves (*Gallicolumba xanthonura*) or Mariana Fruit-Doves (*Ptilinopus roseicapilla*) were obtained during the year.

Guam Swiftlets

Mahlac Cave – Only two censuses of swiftlets at this colony were attempted in FY99. The first, on 7 January, was considered fairly accurate, with a tally of 538 birds (Table 2). The results of a second count on 28 January were questionable because of disturbance problems during the census. Based on the results of the first count only, it appears that the colony has increased by 16-38% to roughly 500-550 birds during the past year. Censuses made from January to March 1998 indicated a colony size of approximately 400-430 birds (DAWR 1998). Reproductive activity in the colony continued to be monitored this year. Nesting seasonality generally agreed with observations from past years (DAWR 1987-1998). Egg and chick production was greatest from February to early November (Table 2).

Snake trapping was resumed at the cave this year because of the continued presence of large numbers of snake tracks in guano on the floor. Trapping with mouse-baited funnel traps began on 12 March and continued through 30 September. During the first 12 weeks of trapping, six traps were placed inside the cave and six traps were set along the crevice outside of the cave's south entrance. On 28 May, all interior traps were moved outside and placed on the roof of the cave. A total of 44 snakes (7 inside, 37 outside) was caught during 2,472 trap nights (468 trap nights inside, 2,004 trap nights outside). More than half of all snakes ($n = 26$; 7 inside, 19 outside) were captured in the first 50 days (300 trap nights inside, 300 trap nights outside) of trapping. All snakes taken inside the cave were

captured from 12 March-30 April. Overall capture rates were considerably lower than in 1996 (DAWR 1996).

Table 2. Results of censuses for island swiftlets at Mahlac and Fachi Caves on Ordnance Annex during FY99. Evidence of reproductive activities of swiftlets is also presented.

Date	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	Reproductive Parameters				
					No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen		
							small	med	large
<u>Mahlac Cave</u>									
3 October 1998	-	-	-	0	8	3-4	8	3	3
29 October	-	-	-	0	4	4-6	3	2	12
30 November	-	-	-	0	1	1	0	2	4
30 December	-	-	-	5	6	2	2	1	0
7 January 1999	538	-	538	-	-	-	-	-	-
28 January	427-527	-	427-527	3	13	4-6	4	3	3
24 February	-	-	-	1	16	3+	8	11	6
2 April	-	-	-	7	12	4-5	5	5	13
7 May	-	-	-	14	39	2-3	7	6	6
28 May	-	-	-	19	30	3-4	4	6	10
1 July	-	-	-	3	19	3-4	3	7	7
29 July	-	-	-	4	10	1	8	5	14
30 August	-	-	-	2	15	3-5	4	7	16
5 October	-	-	-	2	10	4-6	4	13	11
Fachi Cave	no counts made this year								

Key: - = no data gathered.

Trapping was terminated inside the cave in May because of the apparent resulting disturbance to nesting swiftlets, as evidenced by the unusually large numbers of eggs found on the cave floor during the interior trapping period (Table 2). Removal of traps from the cave was followed immediately by a return to "normal" rates of eggs collected on the floor. The source of disturbance to nesting birds from the traps were never determined. Daytime observations did not indicate any unusual responses of the swiftlets to the traps or unusual noises emitted by the mice. Thus, some type of nighttime disturbance seems a more likely explanation. This type of disruption to nesting birds was not observed in 1996. It also suggests that researchers should use extreme caution when conducting any trapping inside the cave in the future, or should refrain entirely from this activity.

Most (95.5%) captured snakes had snout-vent lengths of 84-110 cm, with the largest individual measuring 123.0 cm. Most (70.5%) were females. Three animals (1 caught inside, 2 outside) held swiftlet feathers in their alimentary tracts, but none contained swiftlet eggshell fragments. Two of the snakes with feather remains were caught during the first two weeks of trapping, while the third animal was captured on 18 June.

Fachi Cave – No counts of the colony in Fachi Cave were made in FY99. The cave's east entrance was visited several times during the year, but no indication of flooding was ever observed.

Firebreak 3 Cave – During FY99, night roosting and nesting by swiftlets were recorded in this cave for the first time since at least 1981. An evening observation period failed to detect any birds on 16 November. However, two birds were flushed from the cave during a incidental visit at midday on 15 March. Followup counts at dusk on 19 and 22 March

revealed the presence of 2-3 birds roosting inside. Three birds were still present on 11 May, when a nest with a medium-sized chick was also discovered. The nest was attached to the ceiling inside the second main solution dome nearest the main entrance. On 17 August, three volant individuals were still roosting in the cave overnight and a second chick (large in size) was noted in the nest. Observations were not conducted to determine whether either chick successfully fledged.

Prior to the cave's recolonization by swiftlets, staff from the DAWR, U.S. Fish and Wildlife Service, U.S. Department of Agriculture – Wildlife Services, and Navy had been planning a snake trapping and ceiling modification experiment inside this cave. This study is still planned for implementation in early FY '00. Thirty traps will be placed in the cave, with half set on lower walls within 2 m of the floor and the remaining half attached to the ceiling. An initial phase of trapping will be conducted, followed by efforts to smooth sections of the cave's ceiling to prevent snake access to important former nesting areas. A final trapping period will then be conducted to verify the effectiveness of smoothing measures.

Lumuna, Yigo – No visits to this area were made in FY99.

Mt. Sasalaguan, Merizo – Several hikes into the upper Ajayan River Valley on the south flank of Mt. Sasalaguan failed to produce sightings of swiftlets. Birds have not been recorded in this general area during the 1990s and may no longer be present. Further visits to the area should be made.

Mariana Crows

Crow survey results for this year are reported in Project W-1R-6, Subproject W-4, Study 1, Job 2.

Micronesian Starlings

An Air Force serviceman has continued a small program to build and monitor nest boxes for starlings on AAFB during the year. Results of his efforts have not been summarized to date.

Small numbers of starlings continued to be seen on NCTAMS this year, with nesting activity suspected. An adult and immature starling were seen near the base's post office and cafeteria on 16 September. Single adults were seen on two other occasions at this location in September and August.

Notable Species Recorded on Guam During FY99

Noteworthy records of birds for Guam in FY99 are presented here, some of which, have been included in Wiles et al. (in press). Two Red-tailed Tropicbirds (*Phaethon rubricauda*) flew over the beach at Ritidian Point on 27 May. Observers noted single Matsudaira's Storm-Petrels (*Oceanodroma matsudairae*) several miles off the southwest coast of Guam on 4 April and 13 June.

Lone Common Ringed Plovers (*Charadrius hiaticula*) were recorded at the west Tiyan concrete pads on 24 October and 11 September. Black-winged Stilts (*Himantopus himantopus*) were seen at the large pond on the north side of the Guam International Airport terminal on the following dates: four to five birds from 10 October to 22 January, and one bird on 16 September. Two more stilts were located at the Shell Oil facility in Piti on 22 January. Eighteen Marsh Sandpipers (*Tringa stagnatilis*) occurred at the Agfayan

Bay fish ponds in Inarajan on 16 September. This is the largest count of this species ever reported for Micronesia. Single marked Gray-tailed Tattlers (*Heteroscelus brevipes*) were seen at the Merizo sewage treatment ponds on 23 January and at the Agfayan Bay fishponds on 18 September. The Merizo bird had only one leg, which held an aluminum band, while the Inarajan bird had a blue flag placed above its left leg joint. A Eurasian Curlew (*Numenius madagascariensis*) resided at Togcha Beach from 4-17 October. Two immature Long-billed Dowitchers (*Limnodromus scolopaceus*) were sighted at a pool in a vacant construction site in Barrigada on 4-5 November and represented the first record of this species for Guam. A Red Knot (*Calidris canutus*) occurred at the Agfayan Bay fishponds from 16-19 September. Single Long-toed Stints (*Calidris subminuta*) were noted at the Tiyan pads on 10 October and from 9-12 September. This same location held a Pectoral Sandpiper (*Calidris melanotos*) on 10 October. One Ruff (*Philomachus pugnax*) was observed among a flock of Ruddy Turnstones (*Arenaria interpres*) at a mowed field at AAFB on 17 December. Four more Ruffs were recorded at the large pond north of the Guam International Airport terminal on 27 September.

One to two Black-headed Gulls (*Larus ridibundus*) in non-breeding plumage were sighted in East Agana Bay and Apra Harbor from 9 December to 7 March. A Long-tailed Cuckoo was seen in the Munitions Storage Area, AAFB on 30 June and represented another new species record for Guam. Three or four Fork-tailed Swifts (*Apus pacificus*) were recorded soaring above the cliff top at Ritidian Point on 30 April. This species has not been previously reported in Micronesia during spring migration. A flock of nine unidentified swallows, presumably Barn Swallows (*Hirundo rustica*) was noted at Tagua Point, AAFB from 3-6 August.

RECOMMENDATIONS

1. Develop and implement methods for controlling the brown tree snake.
2. Reinitiate censuses of common moorhens and develop an appropriate habitat improvement and development program.
3. Continue monthly cave censuses and efforts to assess population change and reproductive activity of island swiftlets. Consider snake-proofing Mahlac Cave to protect nesting swiftlets. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofoto River valley about the use of pesticides on their farms.
4. Continue predator control efforts on Cocos Island until complete eradication of monitor lizards and feral cats is attained.

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-7 is \$45,000.

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Report prepared by: Gary J. Wiles and Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7

SUBPROJECT NO.: W-4

STUDY NO.: 1

JOB NO.: 2

JOB TITLE: Survey for Mariana Crows and Their Nest Sites on Guam and Rota
(1460, 1470)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Only seven Mariana crows, *Corvus kubaryi*, are estimated to remain in the Guam population, based on call surveys and locations of known individuals. This number includes two Rota females released on Guam in 1997. Six nests were recorded this breeding season. A single egg clutch was recorded in one nest that was lost, possibly due to snake predation or egg dumping.

BACKGROUND

The Mariana crow is found only on Guam and Rota and is the only species of crow in Micronesia. Though once found throughout Guam, surveys in 1981 estimated 380 crows (Engbring and Ramsey 1984) were present in northern Guam. This number was much lower than the estimate of 1,300 crows on Rota in 1982 (Engbring et al. 1986). By 1986, Michael (1987) reported that only 100 crows remained on Guam. By then, most of Guam's native forest birds had disappeared as a result of brown tree snake predation (Savidge 1987, Conry 1988, Engbring and Fritts 1988). In 1990, the Division of Aquatic and Wildlife Resources (DAWR) began annual surveys using tape-playback of crow calls to monitor the species' status. The initial survey found about 100 crows present in northern Guam. Though crow numbers had decreased since 1981, distribution remained the same (DAWR 1990).

Efforts to reverse the decline of the Mariana crow began in 1986 with attempts to protect active nest sites from snake predation. Sheet metal sleeves and Tanglefoot®, an adhesive resin, were placed around trunks of active nest trees to act as a snake barrier and snake trapping was begun. During the early 1990s, increased nest protection was achieved with the development of electrical barriers and effective snake trapping (DAWR 1991).

In 1996, a select committee appointed by the National Research Council (NRC) completed a review of the Mariana crow recovery program (NRC 1997). Their report compliments and reiterates conservation recommendations for crows found in the recovery plan (Beck and Savidge 1990). Included in their recommendations were that all birds being held in the National Zoo and Houston Zoological Garden be released on Guam. In 1997, the crow population on Guam was augmented by the release of eight captive crows (six from the zoos and two from DAWR's breeding facility) into the wild in northern Guam. Currently, four of the released birds are doing well, the status of one is unknown, and three died 13-219 days after their release.

OBJECTIVES

To inventory Mariana crows and their nest sites to implement recovery efforts, including predator control and other reproductive enhancement efforts (Beck and Savidge 1990).

PROCEDURES

1. Recorded-call playback surveys for Mariana crows were conducted in northern Guam during July. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period when the observer listened for crows. Numbers, distances, and plumage condition of the crows detected were recorded.
2. Areas in the northern Guam were searched during the breeding season (from October through May) for crows. Active nests were closely monitored and appropriate measures to protect them were taken. Locations of active nests were mapped.
3. Young, if found, were monitored.

RESULTS

Surveys

Mariana crows were surveyed on 14 transects totaling 211 stations in eight regions of northern Guam in July (Table 1). A total of two crows were detected on one transect (Munitions Storage Area [MSA]) during the survey, as compared to eight birds on two transects last year (DAWR 1998). The number of crows recorded on the FY99 survey is lower than the actual number of birds still surviving. An additional five crows are known to occur in the MSA and Tarague areas (Figure 1).

Table 1. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1999.

<u>Transect</u>	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	0	0	5
2	36	0	0	0
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	0
8	23	0	0	0
9	9	2	1	0
10	9	0	0	0
11	7	0	0	0
12	9	0	0	0
13	8	0	0	0
14	9	0	0	0
Total	211	2		5

July 99 crow population estimate = 2+5 = 7 birds

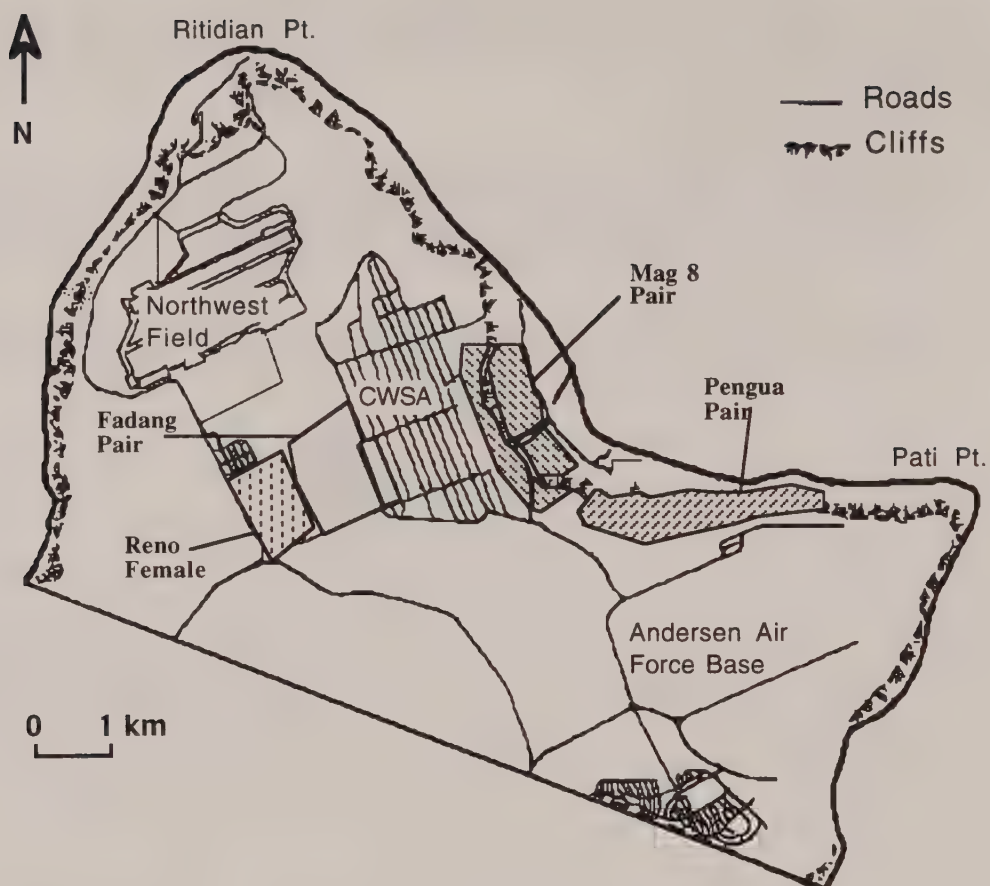


Figure 1. Locations of known crows in the Northwest Field, Munitions Storage Area (CWSA), and Pati Pt. areas as of July 1999. The hatched and dotted areas indicate the approximate home ranges of the birds.

A Rota/Rota pair (“Faia” and “Ahgao”) released in 1997 and known from the previous breeding season was not located during the entire 1998-1999 breeding season. Attempts to find this pair were unsuccessful. The pair had been residing on the upper Tarague Plateau. The estimate of seven birds is a 42% decrease over last year’s count (DAWR 1998) and indicates a continued population decline (Figure 2). This information further supports the importance of translocation to save the crow population on Guam. With only a few remaining birds, efforts to translocate crows from Rota and monitor the released birds should be increased and playback surveys should be discontinued. Information on numbers and distribution would be better obtained from following the known individuals and conducting systematic and intensive searches where birds were last known to exist.

Active nests

Nesting activity decreased in FY99, with six nests recorded this year as compared to nine nests in 1997-1998 (Table 2, Figure 3). Only one single egg clutch was laid during the breeding season. However, this egg was lost, possibly due to snake predation or egg dumping. Two Rota-Guam pairs accounted for five of the nests (Table 2). Their nests were found in *Ficus* (3) and *Elaeocarpus* (2) trees. A Guam pair nested once in a *Glochidion* tree. Its nest was found after it was abandoned.

Table 2. Summary of crow nests constructed on Guam, the stage at which they were found, and their outcome. Productivity of crows is summarized in Table 3. Pairs A, B, and C are the Pipeline/Pengua, Fadang/Guam male, Mag8OL pairs, respectively.

No.	Pair ID	Nest No.	Date Discovered	Nest Stage	Tree species	Snake Proofed	Outcome
1	A	334	10/21/98	Early Base	<i>Ficus</i>		Nest destroyed
2	B	335	12/3/98	Base	<i>Elaeocarpus</i>	12/23/98	No eggs laid
3	A	336	1/25/99	Base	<i>Fiascoes</i>	2/1/99	1 egg
4	A	337	3/2/99	Complete	<i>Ficus</i>	-	Abandoned
5	B	338	4/15/99	Complete	<i>Elaeocarpus</i>	-	Abandoned
6	C	339	4/23/99	Complete	<i>Glochidion</i>	-	Abandoned

There is a single Guam female in the MSA. This female failed to mate.

RECOMMENDATIONS

1. Discontinue annual crow surveys.
2. Continue searches for active crow nests and take appropriate measures to protect these nests from snake predation.
3. Collect pertinent information on the locations of crow nests.
4. Augment the Guam crow population with birds from Rota.

PROGRAM COST

The estimated cost of the Mariana crow project under W-1R-7 is \$80,000.

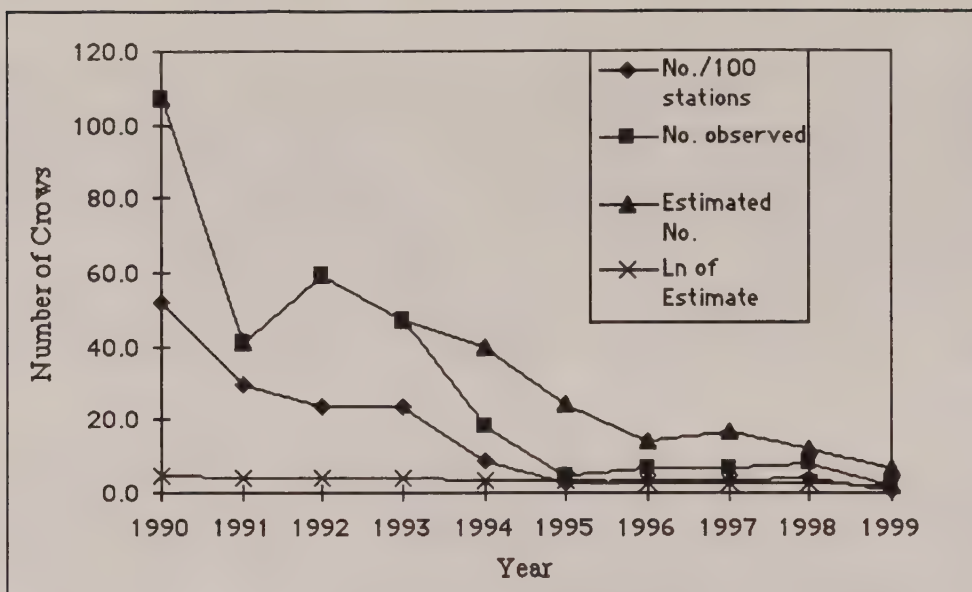


Figure 2. Yearly results of Mariana crow playback surveys made on Guam. The number of birds estimated in 1999 includes 2 Rota crows released in the wild in 1997.

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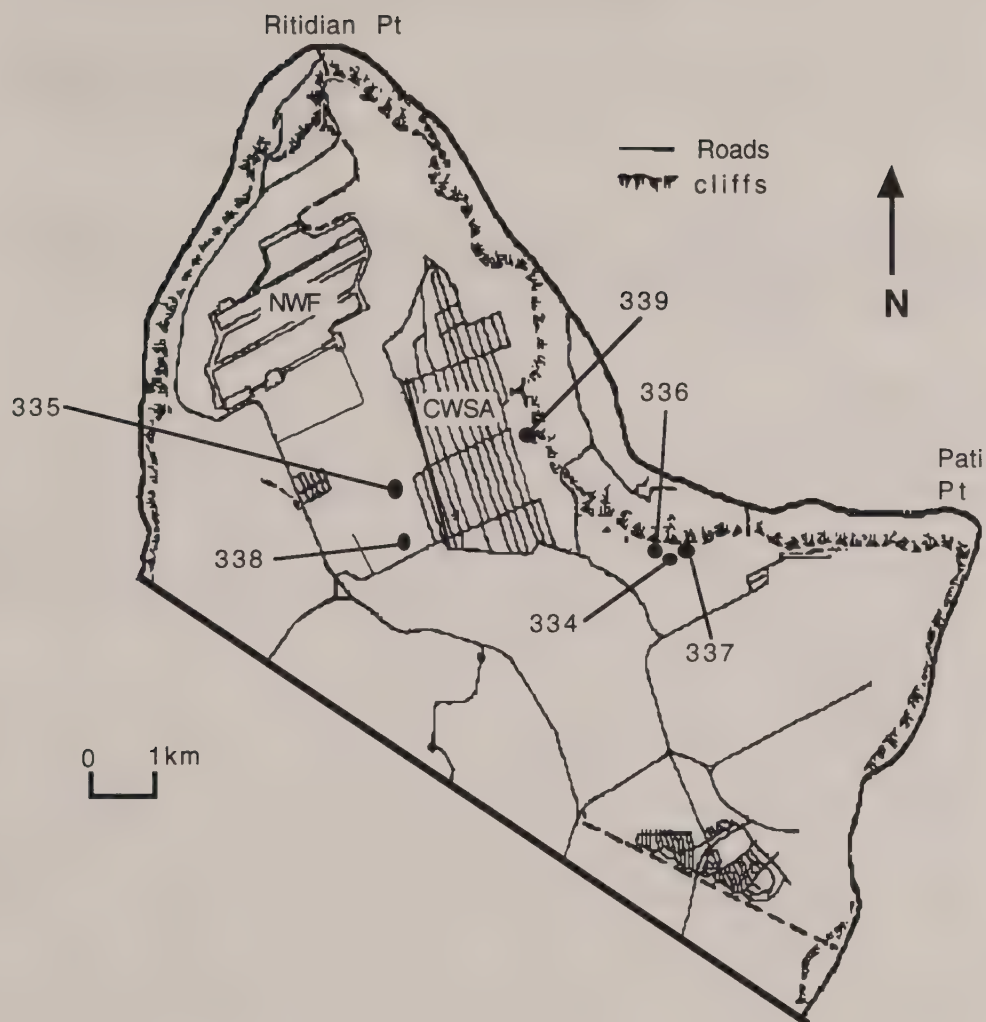


Figure 3. Locations of nests produced during the 1998-1999 Mariana crow breeding season. The Pipeline (Pengua and a male), Faia/Ahgao, and the Mag 8 OL pairs were the only pairs that constructed nests during the season. The Pipeline pair was the only pair that laid eggs.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Current Status, Distribution, and Natural History of Mariana Fruit Bats

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

During FY99, Guam's population of Mariana fruit bats (*Pteropus mariannus mariannus*) ranged in size from an estimated low of 199-235 animals in October and a high of 327-371 animals in February. Numbers were low (< 200 animals) for most of the year at the island's only bat colony. The colony continued to roost at a single site on Pati Point for the fifth consecutive year. The Division of Aquatic and Wildlife Resources (DAWR) assisted in a survey of fruit bats on Sarigan in July. Data were gathered on population size, reproduction, food habits, and roosting behavior.

BACKGROUND

The Mariana fruit bat has been studied by the DAWR since 1962 (DAWR 1964-1998). Considered a delicacy by Chamorro residents, bat abundance declined during the 1960s and 1970s until only a few solitary animals remained (Perez 1972, Wheeler and Aguon 1978, Wiles 1987a). A second species, the little Mariana fruit bat (*P. tokudae*), also occurred on the island, but is now extinct (Wiles 1987a). Reasons for the declines were primarily overhunting and some loss of habitat (Wheeler 1979). Both *Pteropus* occur on the U.S. and Guam Endangered Species Lists. The island's population of Mariana fruit bats grew to an estimated 850-1,000 animals in the early 1980s, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have gradually declined since 1983 because of continued illegal hunting and suspected predation by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b, Wiles et al 1995). During FY98, Guam's fruit bat population ranged in size from an estimated high of 910-980 animals to a low of 210-245 animals (DAWR 1998).

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as recommended in the Mariana Fruit Bat Recovery Plan (Wiles 1990).

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI).

- a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
 - b. Conduct monthly censuses at known bat colonies on Guam.
 - c. Assist the CNMI Division of Fish and Wildlife with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
 3. Determine habitat use of fruit bats. Visit abandoned roosts and record information about terrain and the size and abundance of vegetation present.
 4. Monitor fruit bat imports to Guam from other Pacific islands.
 5. Investigate illegal hunting of fruit bats on Guam. Visit abandoned roosting sites of colonies to determine illegal hunting effort. Assist conservation officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

The island's only known fruit bat colony continued to occupy Roost 1 on Pati Point at Andersen Air Force Base (AAFB) throughout FY99 (Tables 1, 2). This site has been used since July 1994 and has been a preferred roosting location for many years (DAWR 1987-1998).

Table 1. Approximate dates of use of the roost used by the only known colony of Mariana fruit bats on Guam in FY99.

Roost Number	Roost location	Approximate period of use by bats
1	North Pati Point	2 July 1994 - present

Table 2. Counts of Mariana fruit bats at roosts on Andersen AFB, Guam in FY99.

Date	Roost Number									Total
	1	14	15	16	17	18	19	20	21	
6 Oct 1998	204	-	-	-	-	-	-	-	-	204
28 Oct	171	-	-	-	-	-	-	-	-	171
2 Dec	190	-	-	-	-	-	-	-	-	190
31 Dec	213	-	-	-	-	-	-	-	-	213
29 Jan 1999	214	-	-	-	-	-	-	-	-	214
26 Feb	247	0	0	0	0	0	0	0	0	247
5 April	180	0	0	0	0	0	0	0	0	180
10 May	163	-	-	-	-	-	-	-	-	163
27 May	146	-	-	-	-	-	-	-	-	146
28 June	163	-	-	-	-	-	-	-	-	163
2 Aug	161	-	-	-	-	-	-	-	-	161
2 Sept	141	-	-	-	-	-	-	-	-	141
5 Oct	130	-	-	-	-	-	-	-	-	130

- = site was not checked for bats; * = colony was present, but complete count was not made.

Surveys of Fruit Bats on Guam

Count results at Roost 1 followed the same seasonal pattern noted in most previous years (DAWR 1985-1998), with low counts (130-190 bats) obtained from early April to early December and somewhat higher counts from late December to February (Table 2). Colony numbers in FY99 showed considerably less variation than in most previous years. The highest count totaled only 247 animals in February (Table 2), which was a sizable decrease from last year's unusually high tally of 760 bats.

Estimates of fruit bat numbers at the main colony on Pati Point can be made using the high and low roost counts for the year. Because some individuals were probably hidden by thick foliage during counts, the total number of adults in the roost was likely to be 5-10% higher than the actual number recorded. Assuming that about half the colony were harem females and that 10% of these had unweaned young (DAWR 1994), then the roost held an estimated high of 259-272 adults and 13-14 juveniles, or a total of 272-286 bats in late February, and a low of 137-143 adults and 7 juveniles, or a total of 144-150 bats in early October 1999.

Incidental sightings of single fruit bats or pairs of bats were made elsewhere on the island during the year, as follows: daytime sightings – Ritidian Point (4 sightings), Munitions Storage Area on AAFB (3), Mergagan Point (2), Tarague basin and cliffline (2), Tarague clifftop 1 km east of the cliffline road (1), Northwest Field (1), Urunao (1), Pagat cliffline (1), and 1 km south of Mt. Alifan on Ordnance Annex (1); nighttime sightings – Munitions Storage Area (1), west end of Naval Hospital in Anigua (1), and Dandan in Malojloj (1).

Excluding bats residing in the colony at Pati Point, an estimated 40-60 fruit bats are still believed to live solitarily or in small groups in northern Guam, primarily along the cliffline extending from Bijia Point to Iates Point. An additional 15-25 animals probably inhabit the Ordnance Annex and other forested areas in southern and central Guam. Based on these figures, Guam's islandwide population of fruit bats was small for much of the year, with an estimated low of 199-235 animals in early October 1999 and a high of 327-371 animals in February.

Surveys of Fruit Bats on Other Islands

The DAWR assisted the CNMI Division of Fish and Wildlife and U.S. Fish and Wildlife Service (USFWS) with a fruit bat survey on Sarigan in July. Results of the survey are presented in Appendix 1.

Illegal Hunting and Importations

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al. 1992). Poaching still occurs commonly on Rota and other islands in the Marianas (E. Taisacan, pers. comm., 1998). No reports of illegal hunting were again recorded on Guam this year.

No illegal shipments of bats were confiscated by customs authorities on Guam during the year (T. Eckhardt, USFWS, pers. comm.). However, two confiscations occurred on Saipan, as follows: 10 bats from Palau in one shipment and one bat from Yap.

Proposed Downlisting of the Mariana Fruit Bat Population on Guam

In March 1998, the USFWS published a proposal to list the Mariana fruit bat as threatened throughout the Mariana Islands (U.S. Fish and Wildlife Service 1998). This would result in the downlisting of Guam's bat population from endangered to threatened. No action on the proposal was taken during FY99 and a final decision on the ruling is still pending.

Insectivorous Bats

Wiles (1999) reported on two separate cases of insectivorous bats being accidentally transported to Guam in 1997 (see DAWR 1998). An additional incident was reported to the DAWR in July 1999, when contract workers opened a shipping container at a work site in the Munitions Storage Area on AAFB and found a dead insectivorous bat inside. The carcass was disposed of before it could be examined by biologists, thus no specimen was obtained for identification. The container originated from an undetermined location on the U.S. mainland.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).
2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.
4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by DAWR conservation officers.
6. Continue to assist the CNMI as needed with island censuses and other biological studies. Studies conducted on Rota would be most valuable for understanding the aspects of Guam's fruit bat population.
7. Continue to monitor illegal fruit bat imports entering Guam.

PROGRAM COST

The estimated cost of the fruit bat project under W-1R-7 is \$30,000.

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Report prepared by: Gary J. Wiles

APPENDIX 1

A SURVEY OF MARIANA FRUIT BATS ON SARIGAN, MARIANA ISLANDS

PERIOD COVERED: July 1999

INTRODUCTION

A survey of Mariana fruit bats (*Pteropus mariannus*) was conducted on Sarigan, Mariana Islands from 2-7 July 1999. Field work was done as part of a broader inventory of wildlife and vegetation performed by the CNMI Division of Fish and Wildlife and the U.S. Fish and Wildlife Service. The objectives of the bat survey were to estimate the size of the island's population and to gather behavioral information for comparison with other bat populations in the island chain. Sarigan is entirely volcanic with a land area of 5.0 km², and is characterized by steep topography and a maximum elevation of 538 m. Forest coverage is about 35%, with coconut forest (140 ha) dominating over native forest (35 ha). The rest of the island is occupied by grassland, fern cover, or bare ground.

RESULTS AND DISCUSSION

Station Count Results

Evening counts of flying fruit bats were made at four stations offering broad views of the surrounding terrain (Figure 1). Counts began from 1730-1800 hr and lasted until darkness at about 1930 hr. Observers used 7 or 10X binoculars to view animals. The counts provided information on the numbers of bats feeding and moving through each count area and were useful in searching for colonies, based on the presence of sizable numbers of bats dispersing from particular locations. A brief summary of each station count is given below, with the numbers of animals seen presented in Table 1.

Station 1 - This count site was located on the island's west shore and provided an extensive view of the steep hillsides and cliffs along the southwest coast. About 25% of the area was forested, with two-thirds of this being coconut forest. Modest numbers of bats were recorded during the count (Table 1). Half of these entered or departed via the northern side of the count area, while most others remained in the area. No colonies or flyways were detected.

Station 2 - This count was made from the northwest coast near the main camp and gave a broad view from the shoreline up to a high hilltop. The entire area was covered in coconut (90%) and native (10%) forest. Moderate numbers of bats were recorded, most of which entered or departed from the east or remained in the area (Table 1). No colonies or flyways were detected. The goat eradication team started a large grass fire that burned across the summit of the hill during the count. The fire lasted about 30 minutes, produced loud cracking sounds and much smoke that blew to the southwest, and perhaps affected the count results.

Station 3 - This count site was placed at 350 m elevation on a hilltop overlooking the vicinity of the old basaltic lava flow at the north end of Sarigan and was covered in *Chrysopogon* grassland (60%), native forest (30%), and coconut forest (10%). The site showed considerable bat activity, with the largest numbers recorded for any station (Table

Table 1. Results of four station counts for Mariana fruit bats on Sarigan, July 1999.

Station No.	Date	Number of bats viewed in count area									Total ¹
		Depart to N	Enter from N	Depart to E	Enter from E	Depart to S	Enter from S	Depart to W	Enter from W	Remain- ing	
1	6 July	3	5	0	0	1	1	0	0	7	15
2	5 July	0	0	8	4	0	2	0	4	12	26
3	5 July	0	0	3	0	6	3	24	6	4	44
4	5 July	13	4	0	0	4	11	0	0	2	19

¹Animals that entered and then departed a station count area were counted only once in the totals.

1). About half of the animals were concentrated along the west side of the lava flow and suggested to the observer that a small colony was perhaps present (this was erroneous based on other observations made during the week). Most of the bats in this portion of the count area eventually departed to the west or south. Most other bats were sighted east of the lava flow and again, many of these animals departed to the west.

Station 4 - Located on the east side of the island at mid-slope (about 200 m elevation), this count provided a view extending from the shoreline to the top of the island's tallest peak. It was conducted to determine if sizable numbers of bats were dispersing into the forested northern third of the island from the south end. *Chrysopogon* grass with a few scattered coconut trees (60%) and *Nephrolepis* ferns (40%) comprised most of the area. Nineteen bats were recorded, with 11 of these flying northward through the count area from the south (Table 1). Thus, no evidence of large bat numbers in the south was noted.

Colony Counts

Although only one person was primarily devoted to making fruit bat observations during the trip, the remaining 12 field staff provided useful supplemental data, especially on the locations of bat colonies. During their various activities, the overall field crew achieved excellent coverage of the northern half of Sarigan. The southern half of the island with its difficult terrain and fields of dense swordgrass was visited less extensively, primarily to search for goats and to conduct vegetation surveys. It seems unlikely that any major colonies were overlooked during the trip and that most smaller groupings of bats were eventually encountered by team members.

Nine colonies or smaller aggregations of fruit bats (defined as ≥ 3 animals) were recorded during the study, with a possible tenth colony also located (Table 2). All groups of bats were small, numbering from three to an estimated 24 animals (Table 2). Only three sites held more than 15 bats. Five sites (Groups 2, 5, 6, 7, 8, and 9) were occupied at the end of the survey on 6-7 July and held a combined estimate of 51-63 animals. An additional suspected colony was identified downslope from Group 2, but was not visited on 7 July because of time constraints. Flying bats circled this site repeatedly during observations of Group 2, indicating the possible presence of a group of perhaps 10-25 animals. Based on counts of known groups, plus the likely presence a few additional undetected groups, an estimated 75-100 fruit bats were likely present in colonies or small aggregations on Sarigan during the survey period.

Previous authors have also reported small colony sizes of just 15 to perhaps 40 animals on Sarigan (Wiles et al. 1989, Zoology Unlimited LLC 1998, Fancy et. al. 1999). This contrasts notably with the larger colonies of several hundred or more bats that are typical for *P. mariannus* on some other Mariana islands, such as Guam, Rota, Anatahan, and Pagan (Wiles 1987, Wiles et al. 1989, Stinson et al. 1992, Marshall et al. 1996).

Three aggregation sites (Groups 1, 3, and 4) were used only temporarily during the survey period, however, two of these (Groups 3 and 4) were unintentionally flushed by an observer's presence, which may have resulted in their permanent abandonment. Group 1 was not disturbed, but used its roost site for only 1-2 days. The bats in all three groups may have joined other aggregations by 6-7 July.

Six of the nine aggregation sites occurred in northeastern Sarigan, while two others were found in the southern part of the island and another was near the center. All were located at elevations of about 100-350 m. Five groups roosted in either single or clumps of several coconut (*Cocos nucifera*) trees that were sparsely distributed on steep hillsides with short *Chrysopogon* grasslands. Small isolated patches of native forest held three aggregations,

Table 2. Colonies and other small aggregations of Mariana fruit bats observed on Sarigan, July 1999.

Group No.	Dates Observed	Habitat	Approx. Elev. (m)	Species and no. of roost trees	No. of bats counted	Estimated no. of bats present
1 ^a	3 July	large stand of native forest	100		0	0
1	4 July			not recorded	17	17-20
1	6 July				0	0
2	6 July	<i>Chrysopogon</i> covered ridge with scattered coconut trees	200	<i>Cocos nucifera</i> (1)	6	6-8
2	7 July				2	2-5
3	6 July	<i>Chrysopogon</i> covered ridge with 1-2 coconut trees	200	<i>Cocos nucifera</i> (1)	7	7 ^b
3	7 July				0	0
4	4 July	<i>Chrysopogon</i> covered ridge with scattered coconut trees	200	<i>Cocos nucifera</i> (1)	13	13 ^c
4	7 July				0	0
5	7 July	<i>Chrysopogon</i> covered ridge with scattered coconut trees	175	<i>Cocos nucifera</i> (2)	20	20-24
6	5 July	<i>Chrysopogon</i> covered ridge with scattered coconut trees	175	<i>Cocos nucifera</i> (2)	2	2
6	7 July				3	3
7	6 July	an isolated stand of native forest surrounded by <i>Miscanthus</i>	350	<i>Pandanus tectorius</i> (1)	3	3
8	3 July	ravine with a few native trees	250	<i>Ficus prolixa</i> (1)	7	7-8
8	6 July				+ ^d	+ ^d
9	3 July	ravine with a strip of native forest	250	not observed	16	16-20
9	6 July				16	16-20

^aA colony of about 30-40 bats was seen near this location in January-February 1998 (C. Kessler and H. Gideon, pers. comm.)

^bRoost was flushed by the observer.

^cRoost was flushed by the observer.

^dA few bats were present, but not counted.

while only one colony occurred in an extensive stand of native forest. No groups were located in the closed canopy coconut forest occupying the north and west sides of the island. Aggregations used the following roost trees: *Cocos nucifera* (7 trees), *Ficus prolixa* (1), and *Pandanus tectorius* (1).

Limited observations of groups revealed that most were probably composed of harems. Group 5 was viewed in detail for one hour with a 20-60X spotting scope. Two probable harems were present, with nine females and one male identified among the 20 visible bats. The two roost trees likely held separate harems, with harem size estimated at 14-16 bats in one tree and 6-8 bats in the second tree. The male was observed interacting with a female and climbing among roosting perches in a manner resembling harem-male behavior seen on Guam (G. Wiles, unpubl. data). Group 3 was viewed briefly as its members flushed from the tree. An adult male and four females were identified among the seven bats present. Nearly all of the bats present in Group 4 were females with young when that colony was flushed. Fancy et al. (1999) reported seeing an all-male aggregation of 15 bats in 1997.

Abundance and Behavior of Non-Colonial Bats

Solitary roosting and flying fruit bats were regularly seen in all habitats with trees throughout Sarigan, except near the southern end where adequate observations were not made. Pairs of animals were also occasionally encountered. The abundance of non-colonial individuals appeared to be greatest in native forest on the northeastern side of the island and in scattered coconut trees on grassy hillsides along the eastern coast. Both habitats offered either numerous viewpoints or sparse tree cover, making it easy to sight bats. Solitary animals were encountered less often in coconut forest, but detectability was reduced in this plant community because of denser vegetation and fewer viewpoints.

Solitary bats were fairly active throughout the day. Flying individuals were recorded in good numbers at all hours, including the middle hours of the day, and made frequent changes in roosting sites. Some of this activity was due to observer presence and possibly to the general disturbance caused by other team members during their various field activities.

The number of solitary fruit bats on Sarigan was difficult to quantify for a variety of reasons, including poor visibility in closed canopy forests and the high mobility of some individuals. However, based on numbers seen during evening station counts and general daytime observations, a rough islandwide estimate of 75-100 bats is reasonable.

Considerable time was spent making careful observations of bats roosting solitarily to determine the sex ratio and percent of females with young in this segment of the population. Sex and the presence or absence of young were determined for 18 individuals, with a ratio 10 males: 8 females (55.6% male) noted; three of the eight (37.5%) females held non-volant young. Sex ratio data from flying bats were unreliable because adult males with their highly visible genitalia were easier to identify and were possibly more active than females. Precopulatory courtship behavior was observed once between a non-colonial male and female with a medium-sized baby. The male flew in and landed near a female roosting in a coconut tree, courted her unsuccessfully for about 2.5 minutes, and then flew off.

Total Population Estimate

Based on estimates of 75-100 fruit bats in colonies and small aggregations and similar numbers of solitary individuals, Sarigan's fruit bat population was estimated at about 150-200 animals during the count period. This figure is similar to two previous estimates made

for the island. Wiles et al. (1989) reported a minimum of 125 animals in 1983-1984, while Fancy et al. (1999) estimated 170 bats (95% confidence interval of 101-238 bats) in 1997. These counts suggest that the island's bat population has remained fairly constant since the early 1980s. The lack of significant changes in the population's size also gives some very preliminary evidence that large movements of bats among the Northern Mariana Islands may not be a regular occurrence.

Reproduction

Females with babies were commonly observed throughout the survey while roosting and flying. More than half of the females recorded in colonies or small aggregations possessed young, as follows: Group 2, the only identified female had a baby; Group 3, four of six females had babies; Group 4, an estimated 10 of 12 females had babies; Group 5, six of nine identified females had babies; and Groups 8 and 9 combined, five of an estimated 20 females had young. Based on these data, 28 of 50 (56%) colonial females possessed young. Additionally, three of eight (37.5%) females seen roosting alone carried babies. The reproductive data for animals roosting in groups may be biased towards a higher percentage of females with young than in fact was present. Sufficient time was not available to observe all individuals in each group, which is the most desirable method for obtaining true female-young ratios. During incomplete observations, females with babies are sometimes more easily identified because the young usually form a noticeable bulge under their mothers' wings, they often receive additional grooming from the mother, and the extra activity of the babies often helps the observer recognize their presence. Females without young are often less active while roosting and therefore require more time to identify. Based on these considerations, probably 30-50% of the females on the island possessed young during the survey period.

During the survey, 11 babies were classified by size, as follows: one small, nine medium, and one large.

Food Use

Based on direct observations and other evidence (dropped fruit, chewed pellets, and fecal analyses), 20 feeding records were obtained during the survey. Fruit bats used the following foods: the fruits of *Terminalia catappa* (10 occasions), *Neisosperma oppositifolia* (3), *Pandanus tectorius* (2), and *Ficus* sp. (1), the flowers of *Cocos nucifera* (3), and probably sap from the flower stalk of *Cocos nucifera* (1). Additionally, C. Kessler and H. Gideon reported seeing bats making heavy use of *Erythrina variegata* flowers in January and February 1998.

Bats visited our camp on the northwest side of the island each night to eat *Terminalia* fruit. Feeding sign was regularly recorded under other *Terminalia* around the island. Although *P. tectorius* is uncommon on Sarigan, its drupes were heavily fed on in both instances where ripe fruit were found. Despite deliberate searching, no evidence of feeding was located under numerous large *Ficus* trees with ripening fruit, however, *Ficus* seeds were collected from a single fecal splat found beneath the roost of a solitary animal. The dropping was examined with a dissecting microscope on Guam. The seeds were not identifiable to species, but came from *F. tinctoria* or *F. prolixa*.

On 7 July at 1930 hr, four fruit bats were seen clustered around the crown of a coconut tree, where a set of older flower stalks protruded upward. Although the stalks no longer possessed flowers, the bats' activity suggested that the stalks were exuding some type of edible liquid (probably sap) from multiple openings. A dominant bat occupied the stalks, while the other three animals hung 50-100 cm away on separate fronds watching the

dominant individual feed. The bat nearest the center (50 cm away) tried several times to approach the crown and insert its head among the stalks, but was rebuffed each time by brief snarls from the dominant animal. The two outermost bats departed after 9-12 min, and were followed soon after by the dominant individual. The remaining bat immediately moved to the crown and began clambering about to lick different parts of the stalks. It frequently changed positions and returned to relick certain locations that had already been visited. The number of animals involved and the resource defense displayed by the one individual suggests that a desirable food was present.

Uneaten fruits from a variety of species were commonly found on the ground beneath parent trees during the survey. This suggests that Sarigan's bat population was not large enough to consume all available food resources during this particular time period. Only one record of a flying bat carrying a fruit in its mouth was made during the entire survey. This indicates that most bat feeding was taking place in or near the crown of the parent tree.

Evidence of Illegal Hunting

Although fruit bats are protected throughout the CNMI, there is concern that considerable illegal hunting may be taking place on many of the northern islands (Marshall et al. 1996). For example, bat poaching was reported on Sarigan in January 1998 (Zoology Unlimited LLC 1998). Surprisingly little evidence of bat hunting was found during the survey. Fewer than five expended shotgun shells with the small shot appropriate for killing bats were found by four team members who hiked large portions of the island. Additionally, bats appeared relatively tame, indicating that they are not heavily persecuted by people.

Insect – Fruit Bat Interactions

One of the more interesting behavioral observations made during the survey was the large number of fruit bats being bothered by small flying insects. Many roosting bats, which hung with their wings wrapped around themselves, were noticed making repeated rapid shallow flicks of their outer wing. On 6 July, while viewing a male bat at a distance of only 5-7 m on the old lava flow, the observer was inundated by 100-200 small flying insects swarming around and delivering occasional bites to his head and arms. Continued observation revealed that the male bat was also bothered by the same insects and that his wing flicking behavior was in response to their irritation. During 10 minutes of observation, he performed 22.1 wing flicks, 1.3 head-neck shakes, 0.3 body adjustments, and 0.1 leg shakes per minute. A second bat seen in Group 6 on 7 July made 15.0 wing flicks and 1.0 head-neck shake per minute in response to the insects during a second 5-minute period. The irritation seemed great enough to prevent bats from settling into a deep sleep. Bats exhibited wing flicking in all habitats, although several colonies on the eastern and more windswept Chrysopogon-dominated ridges did not seem to be bothered. Later conversations with entomologists from the University of Guam suggested that the insects were possibly a type of biting midge (R. Muniappan, pers. comm.).

It is interesting to speculate whether insect problems may have been responsible for the roosting patterns and site selection of the bats seen in the survey. Animals may have been trying to avoid the insects by choosing the more open and breezy conditions associated with the scattered coconut trees on the northeastern side of the island. The insects may have also been responsible for the frequent movement between roost trees seen in some solitary bats.

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Report prepared by: Gary J. Wiles

PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-7
SUB-PROJECT NO.: W-6
STUDY.: 1
JOB NO.: 1

JOB TITLE: Technical Assistance to Activities Affecting Guam's Wildlife Resources
(1210)

PERIOD COVERED: October 1, 1998 to September 30, 1999

BACKGROUND

The Wildlife Section professional staff of the Division of Aquatic and Wildlife Resources (DAWR) devoted a significant percentage of their time and effort to technical assistance. The pace of development on the island is requiring increasing amounts of time from the Section's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications most of which are local Government of Guam or private sector. In addition, the Section also provides comment and review of numerous activities and proposals from the military bases on Guam that may affect Guam's endangered species and wildlife resources and their habitat. Often this includes commenting on U.S. Fish and Wildlife Service (USFWS) Section 7 consultations concerning impacts of military projects on endangered species. Because of the size and complexity of some of these developments, the Section's review responsibility will require a continuing commitment that often extends beyond project completion.

The professional staff in the Wildlife Section provide technical support to the Division's technical assistance program staff and often take the lead in the review of projects involving their particular expertise, such as those that may have endangered species impacts or those involving wetlands. This effort is extremely important for the management and conservation of Guam's natural resources.

OBJECTIVES

1. To minimize adverse environmental impacts resulting from the construction of recreational, commercial, residential, industrial, military, or public utility facilities.
2. Provide technical assistance to farmers and other landowners, including private, territorial, and federal, for controlling wildlife damage to crops, native habitat, and other property.
3. Provide technical assistance to military and civil agencies relative to the management and protection of Guam's wildlife resources.
4. Provide data and analyses to assist the Department in promulgating hunting regulations for the Territory to provide recreational opportunities for the public, control damage to native habitat, and other needs as they arise.

FINDINGS

Wildlife Section staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications, which were submitted to the Division for review required the Wildlife Section's assistance. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Section staff members actively serve as members of the following groups:

1. Region IX Regional Response Team - Oceania
2. Fish and Wildlife Natural Resource Committee - Andersen Air Force Base
3. Mariana Crow Recovery Team
4. Captive Breeding Working Group, USFWS
5. Area Committee for Oil Spills

Members of the Wildlife Section have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Section staff maintain close liaison with the Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency (GEPA), University of Guam, USFWS, U.S. Geological Survey's Biological Resources Division, U.S. Department of Agriculture's Wildlife Services, U.S. Army Corps of Engineers (ACOE), U.S. National Marine Fisheries Service, U.S. Navy, Coast Guard, and Air Force regarding matters of environmental concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Section staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some more specific Technical Assistance activities of the Wildlife Section included:

1. The Division reviewed and commented on ACOE applications for wetland fill. Mitigation recommendations were often included in these comments. Comments and concerns were also provided to various local agencies. Wildlife staff provided significant input into the responses for these applications. Endangered species were of primary concern to the Section with Mariana common moorhens found in most wetlands on Guam.
2. The Section provided technical support to the Division's enforcement staff by identifying and evaluating wildlife, testifying at court hearings, and recommending disposition for confiscated wildlife.
3. Section staff provided technical assistance to the Department of Agriculture's Plant Protection Quarantine Division by identifying confiscated wildlife and wildlife products, holding wildlife in quarantine, and in general supporting their efforts at preventing illegal imports of wildlife to Guam.

4. The Division reviewed and commented on numerous Environmental Impact Statements/Assessments of proposed developments particularly when wildlife issues were present. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.
5. The Division's Wildlife Section provided comments at the request of the USFWS for numerous Section 7 Consultations under the Endangered Species Act, including the following:
 - a. Numerous military training exercises at AAFB and Naval bases on Guam.
 - b. Several wetland related development activities for civilian and military projects.
 - c. Dept. of Defense programmatic EIS for military training in the Mariana Islands.
6. The Section reviewed and commented on several legislative bills that would affect wildlife.
7. The Section responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing, and importation of wildlife.
8. The Section responded to numerous public requests for information on native wildlife, particularly endangered species.
9. The Section answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearm regulations, hunting seasons and limits, and laws and regulations.
10. Section staff provided technical assistance to numerous farmers and the Air Force and Navy regarding damage by wild pigs, deer, and carabao (water buffalo). Damage control permits requests were evaluated and issued when warranted.
11. Section staff reviewed wildlife-related manuscripts for professional journals. One of our staff is an editor for the University of Guam's journal *Micronesica* and in this capacity reviewed several articles for publication.
12. Section staff assisted in presented hunter safety briefings at Anderson Air Force Base, the Mangilao Community Center, and the University of Guam to provide pertinent information to hunters.
13. Section staff made numerous presentations on fish and wildlife resources at meetings of various organizations during the year.
14. Section staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.
15. Technical assistance and logistic support was provided to various personnel from the USFWS, USGS Biological Resources Division, U.S. Department of Agriculture's Wildlife Services working on the brown tree snake problem on Guam and in the mainland U.S.
16. The Section staff, at the request of numerous developers, met with them, their consultants and other government representatives to discuss proposed development

projects and their potential impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.

17. Section staff provided technical assistance to USFWS and National Marine Fisheries Service law enforcement personnel on various matters including the importation of endangered species items.
18. Technical advice on wetland issues have been provided to the Development Review Section at GEPA.
19. Section staff participated in the Navy Installation Restoration Program by providing information to Navy consultants, accompanying them on several site visits, and attending public meetings.
20. Section staff provided technical support to the ACOE, GEPA, and Navy in evaluating severe erosion and damages to wetland resources caused by firebreak maintenance at Naval Ordnance Annex. Recommendations were made for mitigation of the environmental damage.
21. Staff gave visiting lectures for various University of Guam biology classes on wildlife related topics.
22. Section staff assisted the military in planning field training exercises at various military bases on Guam so that endangered species and their habitat and other wildlife resources would be minimally impacted. Military units involved included:
 - a. Guam National Guard
 - b. Various Air Force units
 - c. Air National Guard
 - d. University of Guam Army ROTC
 - e. Various DOD special operations units
 - f. U.S. Army Reserves
23. Section staff on numerous occasions met with representatives of the press to discuss wildlife issues the media was interested in. Contact was made with the following organizations:
 - a. Pacific Daily News, Guam
 - b. KUAM TV News, Guam
 - c. Guam Cable TV News
 - d. KGTF public radio, Guam
 - e. K-57 radio news, Guam

PROGRAM COST

The estimated cost of the technical assistance project under W-1R-7 is \$60,000.

RECOMMENDATIONS

Continue technical assistance activities in support of the conservation of Guam's wildlife.

Report prepared by: Robert Beck

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: A

JOB NO.: 1

JOB TITLE: Reproductive Enhancement of the Mariana Crow and Other Endangered Species (1470)

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Of the six Mariana crow, *Corvus kubaryi*, nests built during the 1998-1999 breeding season, three were made by a Rota/Guam pair, two by a second Rota/Guam pair, and one by a Guam/Guam pair. Only one single-egg clutch was produced during the season. Of the eight crows released in the wild in 1997, only two continue to survive and are mated. Electrical barriers proved to be highly effective against brown tree snakes, *Boiga irregularis*, in the vertical and 45° positions. Horizontal barriers were only 96% effective, but were improved by adding more ground contact points to the design.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of the native forest birds of Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1987) have indicated that predation by brown tree snake is the main cause of this decline.

Since these studies, attempts to develop effective means of protecting active nests of Mariana crows have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of the adhesive resin Tanglefoot® have all been used as snake barriers around nest trees. The use of sheet metal girdles and Tanglefoot was partially successful but resulted in the mortality of nest trees and was discontinued. One fledgling was produced from a nest in 1989 as a result of Tanglefoot protection.

Since 1990, active nests have been protected successfully with the use of a combination of electrical barriers placed on the trunks of active nest trees and clearing of vegetation around the tree (Aguon et al. 1992). Successful protection of active nests resulted in the fledging of three crows from two nests in 1992 (DAWR 1992) and two from two nests in 1994 (DAWR 1994). These were the first fledglings in the wild since 1985 (Michael 1987), with the exception of the one produced as a result of Tangle-Foot protection in 1989.

OBJECTIVES

Develop methods for controlling brown tree snake predation on active nests of native birds and apply these methods to protect active crow nests.

PROCEDURES

1. Develop methods for snake-proofing active native forest bird nest sites (Figure 1).
2. Implement snake-proofing methods at Mariana crow nest sites.
 - a. The efficacy of horizontal electrical barriers in repelling brown tree snakes was tested. Nighttime tests were conducted with an electrical barrier placed at 0° (horizontal), 45°, and 90° from horizontal (Figure 2).
3. Remove snakes from hack-sites by grid trapping a 1-ha area, with snake traps set at 25-m intervals. In conjunction with grid trapping, perimeter trapping was conducted along roadways surrounding the release site (Figure 3).
4. Crow movements were monitored. For each observation, the date, time, weather conditions (percent cloud cover, wind speed, and presence or absence of rain), habitat type, activity of the bird, species of tree used, location in tree, and height above ground were recorded.
5. Recovered remains of any released birds that died were necropsied to determine possible cause of death. When possible, specimens will be kept for museum purposes as partial skeletons or skins.

RESULTS

Nest Protection

Field use of electrical barriers to protect nests of the Mariana crow from brown tree snake and monitor lizard, *Varanus indicus*, predation continued this fiscal year. The design of this barrier is illustrated in Figure 1. This design proved highly effective during field experiments in 1995 (DAWR 1995). Electrical barriers, powered by 12-volt lead acid batteries, were also equipped with solar panels, which lessened the frequency of battery replacement (Figure 2).

Intensive searches were carried out in northern Guam to locate crow territories and nests during the breeding season (approximately November to May). When an active nest was discovered, an electrical barrier was installed on the trunk of the nest tree at night prior to completion of the nest (Figure 1). Night installation was done to avoid undue disturbance to the nesting birds. Installation before completion of the nest allows for the removal of snakes by trapping prior to egg laying. Trapping for snakes usually involved 10 traps around the nest tree and one in the nest tree. Care and feeding of the mice used as bait in the traps and maintenance of the barrier occurred on a regular basis under the cover of darkness, usually during the early morning hours before sunrise.

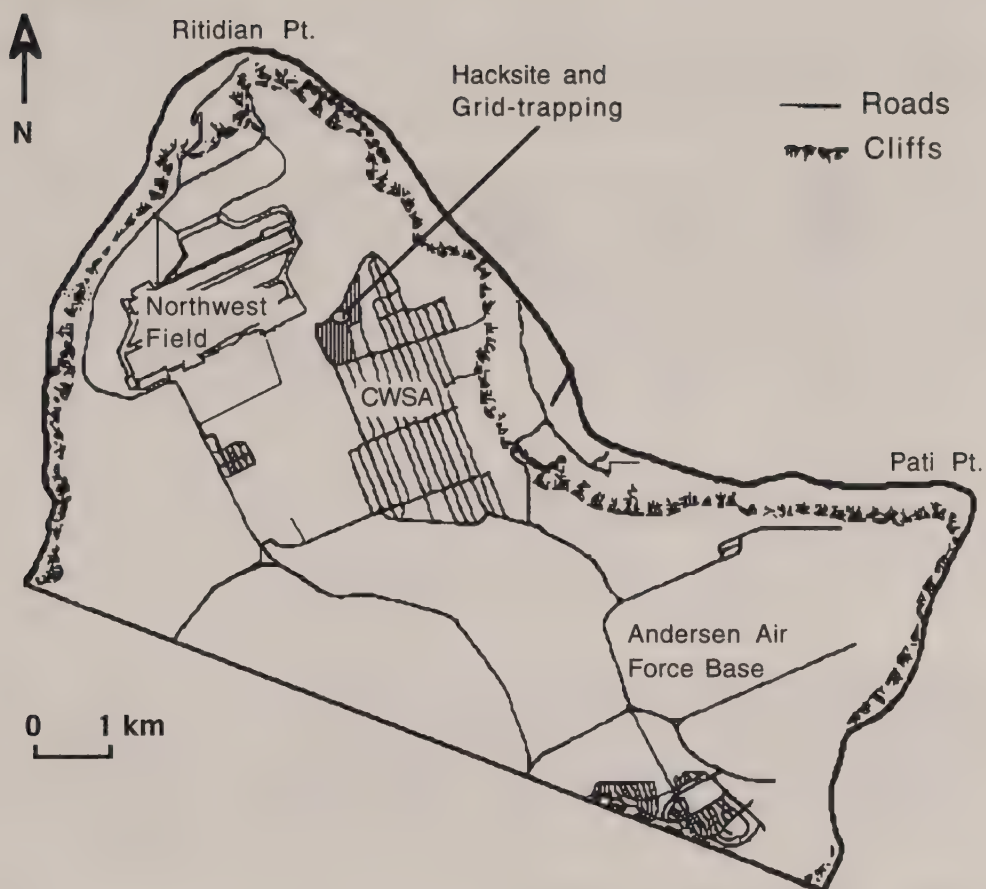


Figure 1. The darkened area in CWSA denotes the area perimeter trapped and the circled area marks the area where grid trapping was conducted and two crows were released.

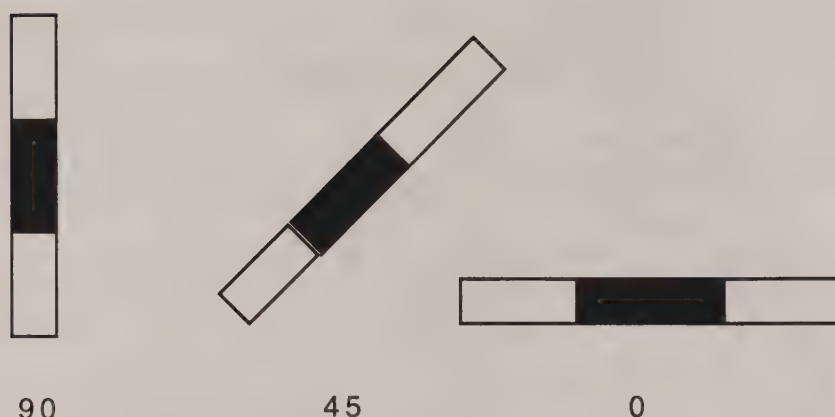


Figure 2. Three orientations of the electrical barrier (dark band) were tested by varying the position of the log, which was supported by a rope and pulley system at both ends.

Breeding activity this season declined. Three of the six total nests recorded were built by a Rota/Guam pair in the upper Tarague Plateau area (Table 1). A single-egg clutch was laid by this pair, but the egg was either eaten by snakes or dumped. A second Rota/Guam pair built a nest that was snake-proofed, but no eggs were laid. A second nest probably belonging to this pair was discovered after it was abandoned. A Guam pair (the Mag 8 Overlook pair) built one nest, but it was also discovered after its abandonment.

Table 1. Summary of crow nests constructed on Guam, the stage at which they were found, and their outcome. Pairs A, B, and C are the Pipeline/Pengua, Fadang/Guam male, Mag8OL pairs, respectively.

No.	Pair ID	Nest No.	Discovered	Nest Stage	Tree species	Snake Proofed	Outcome
1	A	334	10/21/98	Early Base	<i>Ficus</i>		Nest destroyed
2	B	335	12/3/98	Base	<i>Elaeocarpus</i>	12/23/98	No eggs laid
3	A	336	1/25/99	Base	<i>Fiascoes</i>	2/1/99	1 egg
4	A	337	3/2/99	Complete	<i>Ficus</i>	-	Abandoned
5	B	338	4/15/99	Complete	<i>Elaeocarpus</i>	-	Abandoned
6	C	339	4/23/99	Complete	<i>Glochidion</i>	-	Abandoned

While snake proofing is important in improving the nesting success of crows by preventing snake predation, other additional factors are limiting reproductive success. The lack of breeding activity this season is more evidence of an aging population of crows on Guam. It is recommended that other management techniques be implemented (e.g., translocation of fertile eggs or nestlings from Rota) to improve the reproductive success of these birds.

Efficacy of Horizontal Barriers

The efficacy of horizontal electrical barriers was determined by a series of nighttime laboratory tests with a barrier set in various positions (0° (horizontal), 45°, and 90° (vertical)). Twenty-nine trials were conducted at each orientation (Figure 2).

Results indicated that the barriers were 100% effective at 45° and 90°. However the barrier was breached by one of 29 snakes at a 0° orientation. The snake was able to avoid being shocked by maneuvering over the positive wires without touching the ground wires. Only when the snake got to the mesh skirt did it receive a major shock from the barrier. Modifications were then made to the horizontal barrier to prevent the snakes from crossing. These included increasing the number of ground wires and placing nails into the branch so that the tops of the nails were level with the positive wires. The nails were then grounded by wrapping each wire that was grounded. Trials were then repeated on the new barrier to determine if the modifications were effective.

Results of the second round of tests indicate that the modified barrier was effective at a 0° orientation. Of the 29 snakes used in the experiment, 26 (90%) attempted but failed to cross the barrier, one (3%) did leave the release cage, and two (7%) dropped to the ground before reaching the barrier.

Preparation of Hack-sites/Predator Control

Prior to the release of crows into the wild, grid trapping was conducted in the immediate area of the hack-site and perimeter trapping was done in the general area. From November 1998 to September 1999, grid trapping recorded an average of 0.10 (SD = 0.095, range = 0 – 0.45) snakes per trap per week. The highest trap rates were recorded during the first few weeks of trapping. A total of 98 snakes were caught during this period (Figure 3).

Survival of Released Crows

Only two of the six Rota crows brought from mainland zoos and released on Guam in 1997 are known to remain. Both birds are females and have survived in the wild for 925 and 912 days. Two young wild-hatched birds from Rota were hand-reared on Guam and released in the MSA in September 1999 (Figure 1). The birds survived only 2 and 13 days. The first died of asphyxiation when a small leaf and insect part became lodged in its esophagus, thus blocking the trachea. The second bird died of hepatitis. Predation, trauma, and malnutrition were ruled out. Tissues were sent for histological examination. In both cases, the weight and condition of the birds were excellent.

RECOMMENDATIONS

1. Implement proven methods for protecting nesting Mariana crows.
2. Conduct *in situ* tests of methods which prove effective in laboratory experiments on actual active nest trees.
3. Conduct laboratory tests of the efficacy of electrical barriers on horizontal trunks.

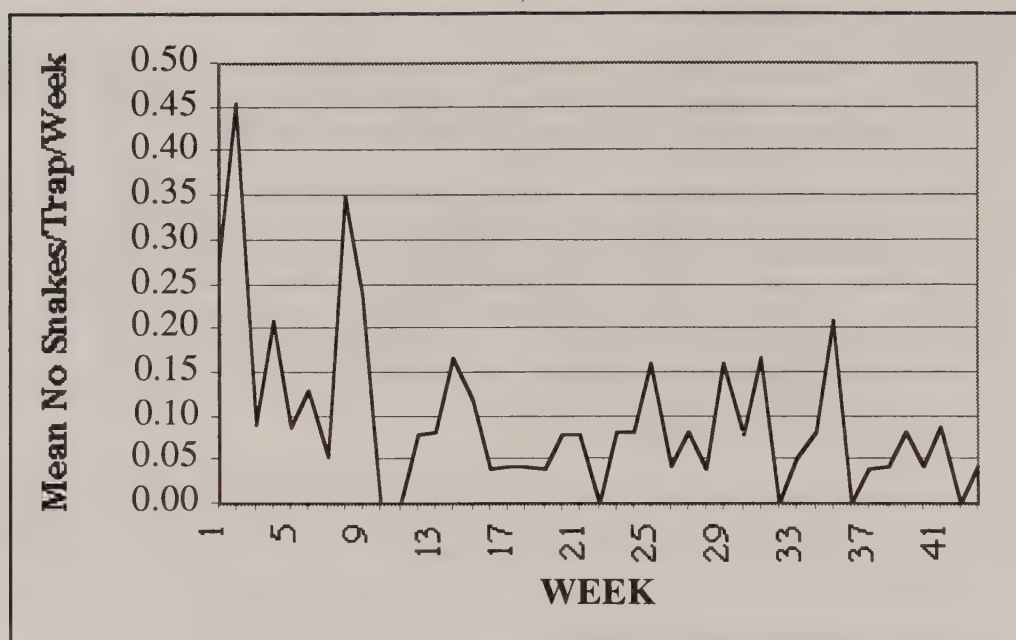


Figure 3. The average number of snakes caught per trap per trap week from November 1998 – September 1999. A total of 98 snakes were caught during this period.

4. Explore the feasibility of area-wide snake control and exclusion of snake from larger areas encompassing nesting territories of crows with the use of barriers.
5. Explore and implement other methods or techniques to improve reproductive success of nesting birds to be used in conjunction with nest protection, i.e., translocation of crows from Rota.
6. Implement recommendations by the NRC for the recovery of the Mariana crow on Guam and Rota.

PROGRAM COSTS

The estimated cost for this project under E-2-2 is \$80,000.

LITERATURE CITED

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Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. *Ecology* 68(3):660-668.

Report prepared by: Celestino F. Aguon and Lloyd B. Dicke

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

STUDY NO.: A

JOB NO.: 2

JOB TITLE: Area-Wide Control of Brown Tree Snakes

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Two Mariana crow (*Corvus kubaryi*) nests were snake-proofed during the year. Perimeter and grid trapping was conducted in the Munitions Storage Area (MSA) on Andersen Air Force Base to remove snakes prior to the release of two crows at a hack site.

BACKGROUND

Since the brown tree snake (*Boiga irregularis*) invaded Guam in the 1940s, the island's avifauna has rapidly declined (Savidge 1987, Conry 1988, Jaffe 1994). Despite of this impact, the Mariana crow continues to survive in the wild in very low numbers.

For those species that remain in the wild on Guam, protection of nests with barriers may be a way of reducing further decline. Electrical barriers have been employed successfully elsewhere to protect bird nests from mammalian predation. Campbell (1999) tested various fence designs for excluding brown tree snakes from 1-ha plots in Northwest Field. In their review of the Mariana crow, the National Research Council (1997) recommended that electrical barriers be used to protect active nest trees. Furthermore, they recommended that research, development, and implementation of methods to control brown tree snakes be expanded.

Techniques required to successfully conduct a translocation project have been tried by the DAWR and proven satisfactory, including protection of nest trees from snakes and hand rearing of crow chicks. The development of an effective electrical snake barrier to protect crow nests from snake predation resulted in five birds being fledging from wild nests between 1993 and 1995 (Aguon et al. 1998). In 1996, two crows were successfully hand-reared from eggs retrieved from protected nests and artificially incubated. These juveniles were hacked into the wild in 1997. Of these birds died 219 days after its release due to unknown causes, while the status of the second bird remains unknown.

OBJECTIVES

To implement area control methods for brown tree snakes as recommended in the recovery plans for Guam's endangered birds and fruit bats.

PROCEDURES

1. Install electrical barriers to the trunks of active Mariana crow nest trees at night and before the start of the incubation period.

2. Prepare release sites by trapping for snakes prior to the introduction of crows. Begin grid-trapping in a 1-ha area around release sites at least one month before the release of crows into the wild.
3. Maintain records of the numbers of snakes caught, their sexes, weights, total lengths, and snout-to-vent lengths.

RESULTS

Electrical Barriers - Two Mariana crow nests were snake-proofed using electrical barriers on the nights of 23 December 1998 and 1 February 1999. The second nest held a single egg, which was dumped or preyed on on about 9 February.

Release Site Preparation - Snake trapping was performed to prepare a hacksite in the MSA for the release of the translocated crows. Trapping began in June 1998, when 112 traps were installed along the shoulder of the road encompassing the area (Site A, Figures 1, 2). Capture rates from perimeter trapping ranged from 0-3.5 snakes per 100 trap nights. A 100 m x 100 m trapping grid, established in November 1998, initially recorded. Capture rates on the grid fell from 6.4 snakes per 100 trap nights to a modal number of 1.0 snakes per 100 trap nights during the last few months.

Two young wild-hatched birds from Rota were hand-reared on Guam and released in the MSA in September 1999. The birds survived only 2 and 13 days. The first died of asphyxiation when a small leaf and insect part became lodged in its esophagus, thus blocking the trachea. The second bird died of hepatitis. Predation, trauma, and malnutrition were ruled out. Tissues were sent for histological examination. In both cases, the weight and condition of the birds were excellent.

RECOMMENDATIONS

1. Continue translocation of eggs, chicks, and adults.
2. Continue snake-proofing of active nest trees.
3. Continue area-wide snake control via grid-trapping and/or perimeter trapping at release sites.

PROGRAM COSTS

The estimated cost for this project under E-2-2 is \$40,000.

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This report was prepared by: Celestino F. Aguon and Lloyd B. Dicke

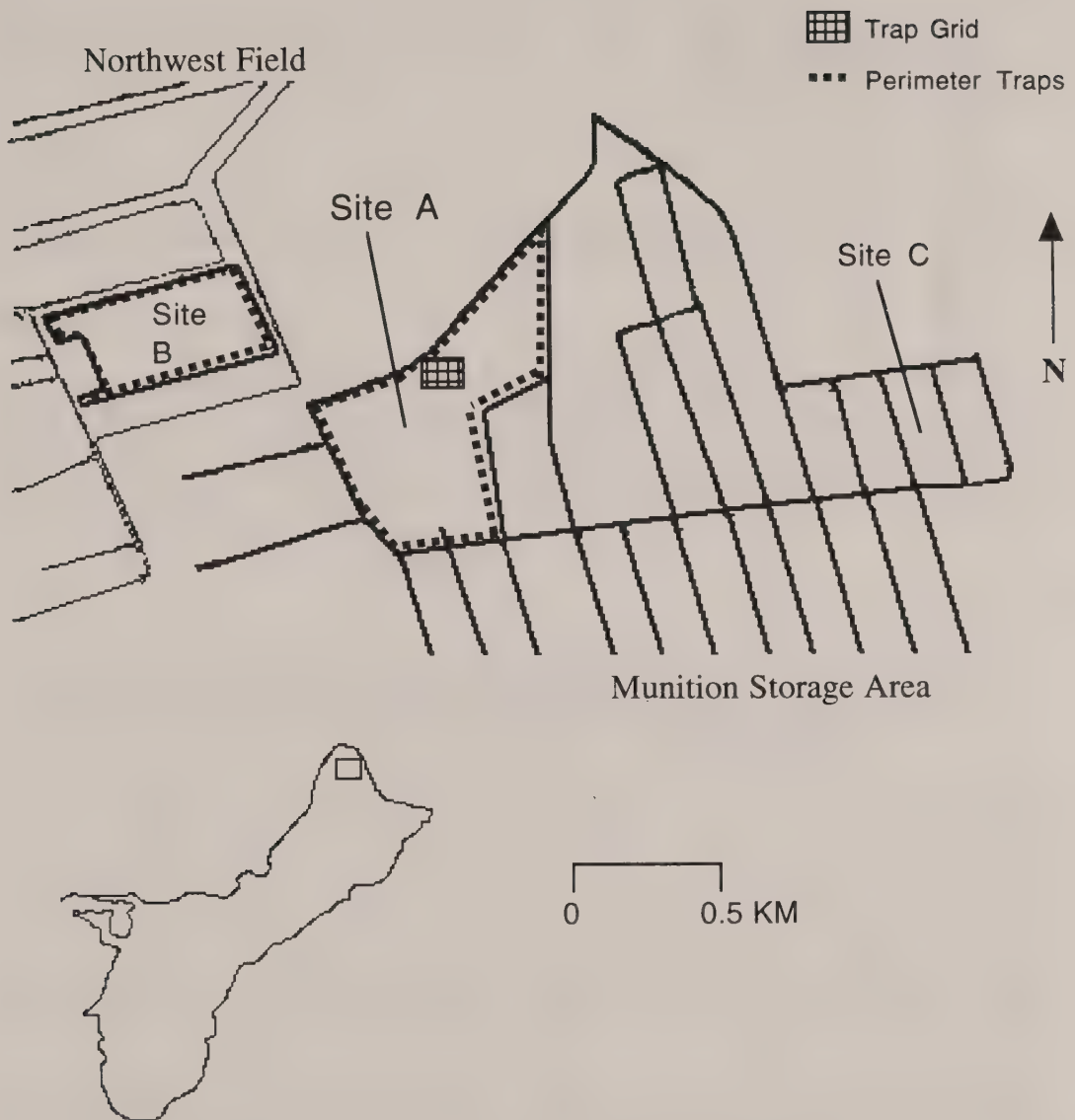


Figure 1. Locations of three sites slated for Mariana crow releases and area-wide snake control. Site A (42 ha in size) is an ideal site since up to four releases of crow can be made in this area. Snake control is ongoing in Areas A (perimeter and grid trapping) and B (24 ha in size), also known as Area 50. A static snake barrier attached to an existing cyclone chain-link fence encompasses Area B. Guam Rails, *Gallirallus owstoni*, have been reintroduced into Area B. Snake trapping is not being conducted in Area C (MSA-2). Two crows were released in Area A in August 1999.

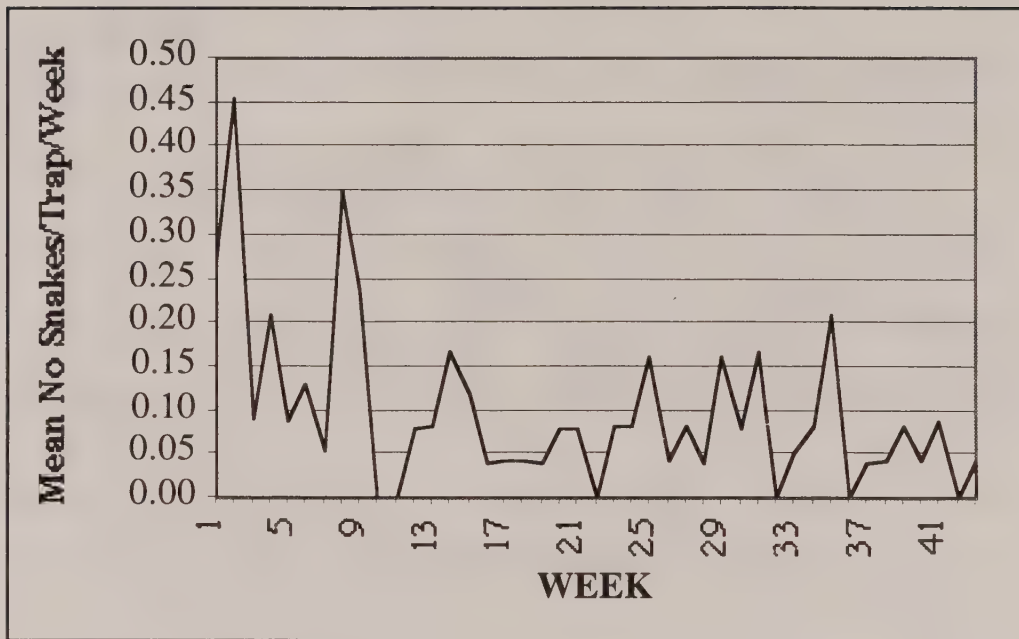


Figure 2. The average number of snakes caught per trap per trap week from November 1998 to September 1999 in grid-trapping Area A, see Figure 1. A total of 98 snakes were caught during this period.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2
SUB-PROJECT NO.: A
JOB NO.: 3

JOB TITLE: Translocation of Mariana Crows

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Activities associated with translocation of Mariana crows (*Corvus kubaryi*) from Rota to Guam began with the issuance of endangered species permits from the U.S. Fish and Wildlife Service's (USFWS) and Commonwealth of the Northern Marianas Islands (CNMI). Two approximately 14-day old nestlings were collected on Rota and brought to Guam for handrearing. Additionally, Division of Aquatic and Wildlife Resources (DAWR) staff made two trips to Rota to capture crows, but did not have success.

BACKGROUND

Since the brown tree snake (*Boiga irregularis*) invaded Guam in the 1940s, the island's avifauna has rapidly declined (Savidge 1987, Conry 1988, Jaffe 1994). Despite of this impact, the Mariana crow continues to survive in the wild in very low numbers.

The federal recovery plan for native forest birds on Guam and Rota makes an interim recovery objective for the Mariana crow as the maintenance "... of at least 700 crows on Rota and to restore the Guam population to at least 700...." (Beck and Savidge 1990). A recent study of the status of the Mariana crow stressed the importance of having multiple populations and recommended that an additional crow population be established on another island (National Research Council 1997). Translocation of Mariana crows from Rota to Guam, as outlined in the recovery plan, is currently the best avenue to achieve the above objectives. Recently, the Mariana Crow Recovery Team, a committee organized to oversee the preservation and recovery of the species, endorsed the translocation of a limited number of crows from Rota to Guam.

Techniques required to successfully conduct a translocation project have been tried by the DAWR and proven satisfactory, including protection of nest trees from snakes and handrearing of crow chicks. The development of an effective electrical snake barrier to protect crow nests from snake predation resulted in five birds being fledging from wild nests between 1993 and 1995 (Aguon et al. 1998). In 1996, two crows were successfully hand-reared from eggs retrieved from protected nests and artificially incubated. These juveniles were hacked into the wild in 1997. Of these birds died 219 days after its release due to unknown causes, while the status of the second bird remains unknown.

In 1993, six crows were captured on Rota and sent to the National Zoo's Conservation and Research Center in Front Royal, Virginia and the Houston Zoo. They were then transferred to back Guam and released into the wild in 1997. Two of the birds currently remain alive and are interacting with wild Guam crows, while the status of two others is

unknown. A female and a male died 13 and 34 days, respectively, after their release. Causes of death are unknown, but necropsies found no evidence of snake predation. The decline of the population of crows on Guam will continue unabated without supplementation of birds from Rota.

OBJECTIVES

To support reproduction of Mariana crows on Guam by translocating adults, eggs, and chicks from Rota.

PROCEDURES

1. Collect eggs and/or chicks from nests of Mariana crows on Rota and transport them to Guam.
2. Hand-rear nestlings and hold them in captivity until their release in appropriate areas.
3. Prepare release sites by trapping for snakes prior to the introduction of crows.
4. Capture adult Mariana crows on Rota and release them as soon as possible in appropriate forested areas on Guam.
5. Monitor crow movements after their release and record their locations, as well as the date, time, weather conditions (percent cloud cover, wind speed, and presence or absence of rain), habitat type, activity of the bird, the species of tree being used and location in tree, and height above ground.
6. Necropsy the carcasses of any birds that die to determine their possible cause of death. If possible, keep specimens for museum purposes as partial or complete skeletons or skins.

RESULTS

Permits - The DAWR was received the USFWS's Endangered Species Subpermit GDAWR-2 for its Mariana crow work in the 1998-1999 breeding season. The permit allowed the take of up to 6 adult crows and 18 eggs/chicks. The CNMI issued a scientific collecting permit (No. 01506) to DAWR, which expires on December 21, 1999. Restrictions in this permit reflected conditions set in the USFWS permit. The Mayor of Rota issued his concurrence to the taking of crow eggs, chicks, and adults. In his letter, the date to take adult birds was extended to May 15, 1999. Subsequently, the USFWS and CNMI (Permit No. 01508) also extended their deadlines to capture birds.

Translocation of Adult Crows - A total of 221.7 hours was spent netting for crows during two trips to Rota from January 11-18 and February 13-24. Mist netting was conducted at six sites, including the Songsong, Pona Point, Tatgua, Coconut Village, and Swimming Hole areas. Nets were opened from about dawn to about 4 hours after sunrise, and from about 3:00 p.m. until dark.

In spite of the mist-netting efforts, no crows were caught. The lack of netting success probably stemmed from several factors. The areas netted did not have forest cover that enhanced the "invisibility" of nets. Because crows move cautiously through the forest, they are less likely to run into the nets. Increased visibility of nets as the day progressed probably contributed to the lack of success. Even when nets were used with crow models and playback, crows were not stimulated enough to fly into the nets. All the birds selected for netting were non-breeding. At least one pair had a juvenile.

Future attempts to catch crows should include prebaiting and using other forms of trapping or a combination of trapping techniques. Trapping birds at old nests may increase netting success. Mariana crows are known to visit old nests possibly to forage for insects hidden among the stick structures. Use of live caged crows might excite wild crows enough to cause them to fly into the mist nets. No matter what technique is used, focal trapping (i.e., trapping a particular bird or pair of birds) will probably be much more difficult than trapping birds randomly.

Translocation and Hand-Rearing of Crow Chicks - Because approval of the permits came late in the breeding season, only a few opportunities were available to move chicks from Rota to Guam. In a few instances, nests were preyed on before the eggs or chicks could be collected.

Two chicks were taken from two nests on Rota and transported to Guam on January 7 and April 29, 1999. At the time they were collected, the chicks, known as “Una” and “Segundo”, were about 21 and 17 days old, respectively. They were transported in a portable brooder and hand-carried on a commercial flight. The chicks were pulled from their nests less than an hour before their flights to Guam. Thus, transport time was minimized and no complications occurred during transport.

Release Site Preparation – Snake trapping was performed to prepare a hacksite in the Munitions Storage Area (MSA) for the release of the translocated crows. Trapping began in June 1998, when 112 traps were installed along the shoulder of the road encompassing the area (Site A, Figures 1, 2). Capture rates from perimeter trapping ranged from 0-3.5 snakes per 100 trap nights. A 100 m x 100 m trapping grid, established in November 1998, initially recorded. Capture rates on the grid fell from 6.4 snakes per 100 trap nights to a modal number of 1.0 snakes per 100 trap nights during the last few months.

Survival of Released Crows

Only two of the six Rota crows released on Guam in 1997 were known to survive during the 1998-1999 season. Both are females with Guam mates and have now been in the wild for 912 and 925 days.

Two young wild-hatched birds from Rota were hand-reared on Guam and released in the MSA in September 1999. The birds survived only 2 and 13 days. The first died of asphyxiation when a small leaf and insect part became lodged in its esophagus, thus blocking the trachea. The second bird died of hepatitis. Predation, trauma, and malnutrition were ruled out. Tissues were sent for histological examination. In both cases, the weight and condition of the birds were excellent.

RECOMMENDATIONS

1. Continue the translocation of eggs, chicks, and adults from Rota to Guam.
2. Hand-rear chicks with live models or in company of other chicks.
3. Cross-foster chicks into active nests on Guam, using non-egg producing pairs as surrogates.
4. Continue snake-proofing active nest trees.

5. Continue monitoring Rota crows released on Guam.
6. Explore techniques for capturing crows.
7. Renew DAWR permits from the USFWS and CNMI to continue translocation activities.

PROGRAM COSTS

The estimated cost for this project under E-2-2 is \$25,000.

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Report prepared by: Celestino F. Aguon

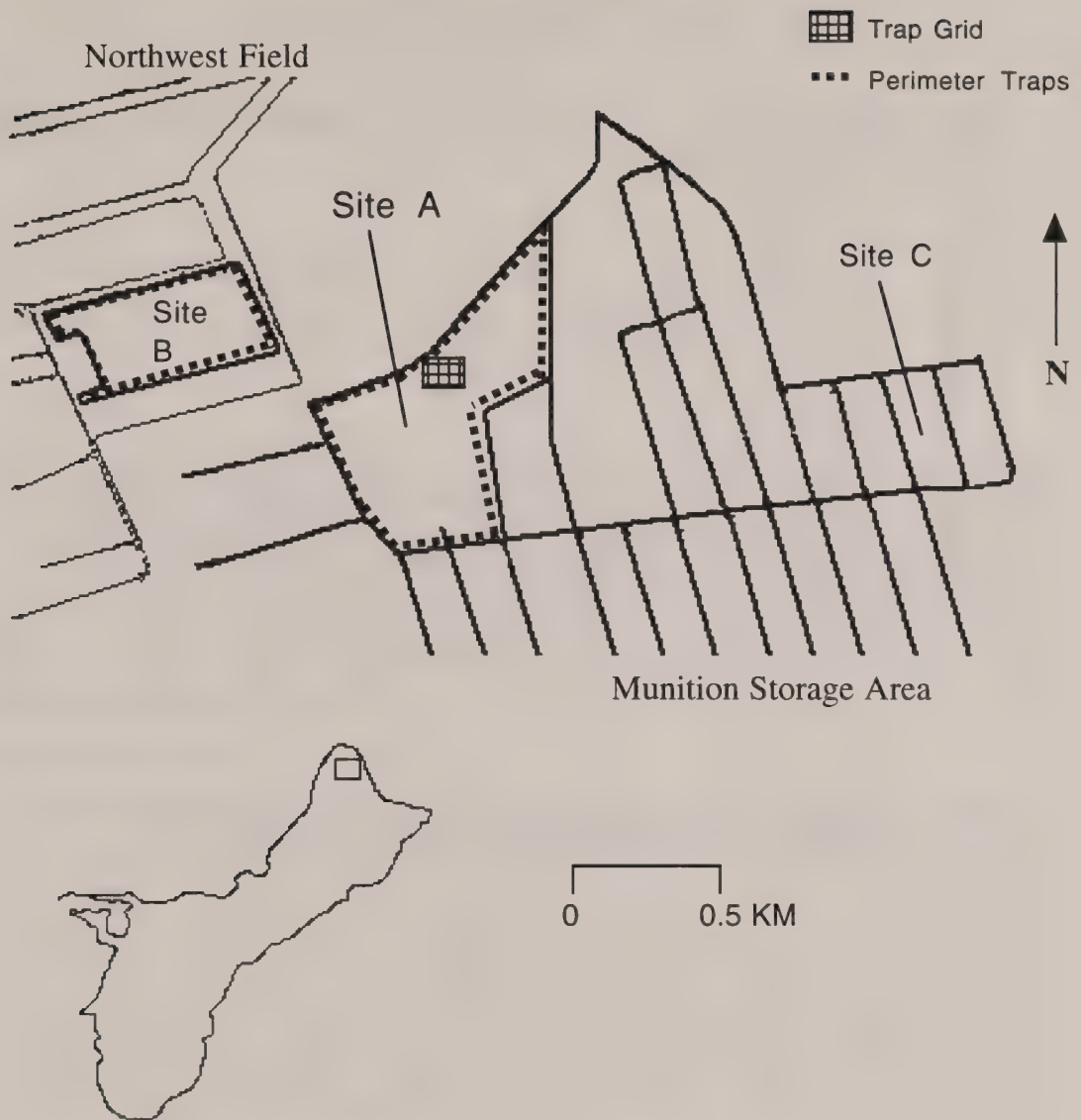


Figure 1. Locations of three sites slated for Mariana crow releases and area-wide snake control. Site A (42 ha in size) is an ideal site since up to four releases of crow can be made in this area. Snake control is ongoing in Areas A (perimeter and grid trapping) and B (24 ha in size), also known as Area 50. A static snake barrier attached to an existing cyclone chain-link fence encompasses Area B. Guam Rails, *Gallirallus owstoni*, have been reintroduced into Area B. Snake trapping is not being conducted in Area C (MSA-2). Two crows were released in Area A in August 1999.

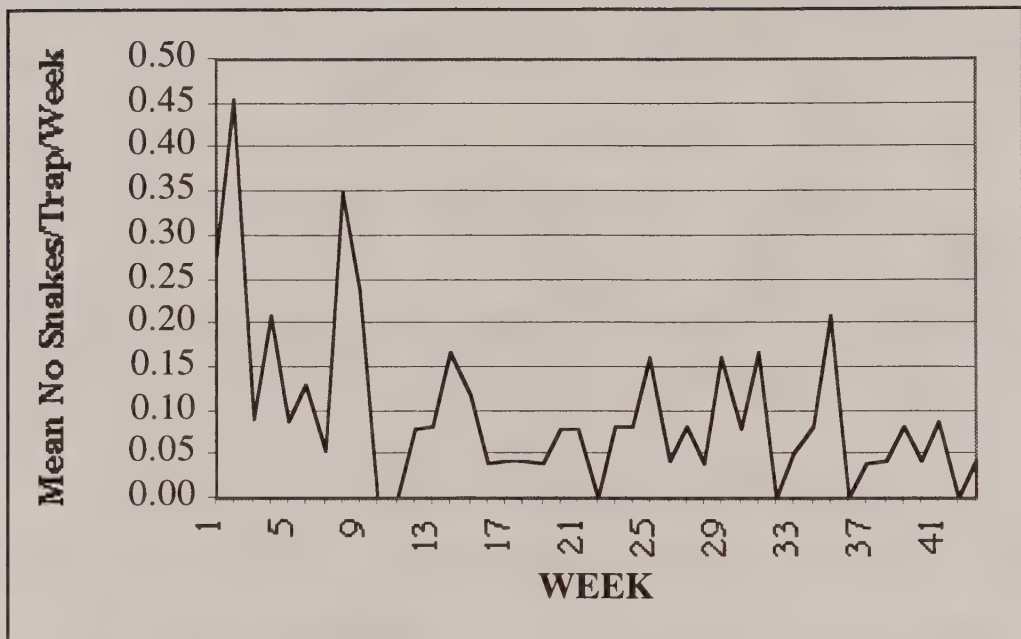


Figure 2. The average number of snakes caught per trap per trap week from November 1998 to September 1999. A total of 98 snakes were caught during this period.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: B

JOB NO.: 1

JOB TITLE: Captive Propagation of Guam Rails

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

The number of Guam rails, *Gallirallus owstoni*, at the Division of Aquatic and Wildlife Resources' (DAWR) captive breeding facility decreased from 129 birds on October 1, 1998 to 120 birds on September 30, 1999. Eighteen breeding pairs produced 223 eggs, 165 (74%) of which hatched. One hundred twelve (68%) chicks lived for at least 30 days of age, were banded, and added to the captive flock by September 30, 1999. One hundred rails were sent to Rota and released in the wild, 16 rails were released in Area 50 on Guam, and 2.2 (males:females) rails were transferred to Guam from mainland zoos. Six birds died at the DAWR breeding facility, while one young bird died during its transfer to San Diego Zoo for medical treatment.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Zoo and Aquarium Association, (AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984).

The Guam rail and Guam subspecies of the Micronesian kingfisher were successfully brought into captivity (DAWR 1983-1986), with the capture of 19 and 31 wild birds, respectively. Rails first bred at the DAWR's facility on Guam and later at the Conservation and Research Center of the National Zoological Park during 1984. In FY99, 14 rails hatched in mainland zoos, with eight surviving to fledge.

OBJECTIVES

1. Manage captive breeding programs for the Guam rail at zoos on the U.S. mainland through the AZA Species Survival Plan (SSP) by providing breeding recommendations. Produce at least four offspring per year from every pair of Guam rails in zoos.

2. Produce 120 Guam rails annually on Guam for release and establishment of an experimental wild population on Rota, Commonwealth of the Northern Mariana Islands.
3. Produce at least four offspring per year from genetically valuable birds (birds with mean kinships lower than population average and founder representation from under represented family lines).

PROCEDURES

1. Conduct routine maintenance and operation of a cooperative captive breeding program for the Guam rail with the AZA and its member zoos.
2. Network with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
4. Breed rails in sufficient numbers (120 birds per year) to support the continuing introduction of the Guam rail to Rota.

RESULTS

There was a net decrease of nine Guam rails at the DAWR captive breeding facility during FY99. Eighteen pairs produced 223 eggs, of which 165 (74%) hatched and 112 (68%) survived to fledge. Six deaths occurred at the facility. One female died as a result of mate harassment. One female was eggbound. A tame rail died of suspected poisoning. A young bird was killed by a neighbor that gained access to its cage through a hole in the wire mesh. One rail with an old severe leg injury died of emaciation. One rail died of old age. One death occurred away from the facility, when a young rail with a serious leg injury was being sent to the San Diego Zoo for medical treatment. The bird froze in the cargo compartment of the aircraft while in transit. The facility received 2.2 rails in November that hatched at San Diego Wild Animal Park (2.0), Lincoln Park Zoo in Chicago (0.1), and Baton Rouge Zoo (0.1). One adult female escaped from a breeding pen and was subsequently captured after three days.

At the beginning of FY99, seven of the 10 breeding pairs at the DAWR facility had to be separated due to increased productivity and limited cage availability. A total of 22 holding pens were added to the facility and breeding was resumed in February.

The large amount of offspring produced allowed for three releases on Rota and Guam in FY99. The first release of 16 rails took place in November on Guam in Area 50, a fenced 24-ha plot of natural habitat that had been subjected to intense snake trapping and removal. One hundred birds were released on Rota in February (50 birds) and August (50 birds). Successful reproduction was documented after all three releases.

RECOMMENDATIONS

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail with the AZA and its member zoos.

2. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.
3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of rails between Guam and mainland U.S. zoos.
4. Breed rails in sufficient numbers (120 birds per year) to support the continuing introduction of Guam rails to Rota.
5. Coordinate with all SSP participants for the transfer of Guam rails produced in zoos to Guam for the purposes of captive breeding at the Guam facility or for release on Rota.

PROJECT COST

The estimated cost of this project under E-2-2 is \$150,000.

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Report prepared by: Suzanne Medina and Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: B

JOB NO.: 2

JOB TITLE: Mariana Crow Avicultural Support

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

No Mariana crow (*Corvus kubaryi*) eggs were produced in the wild on Guam this year for artificial rearing at the Division of Aquatic and Wildlife Resources' (DAWR) facility. Two crow chicks (1 male, 1 female) were removed from nests on Rota and hand-reared on Guam. Both birds were released in the Munitions Storage Area (MSA) on Andersen Air Force Base (AAFB) on September 21, 1999.

BACKGROUND

Since the brown tree snake (*Boiga irregularis*) invaded Guam in the 1940s, the island's avifauna has rapidly declined (Savidge 1987, Conry 1988, Jaffe 1994). Despite of this impact, the Mariana crow continues to survive in the wild in very low numbers.

The federal recovery plan for native forest birds on Guam and Rota makes an interim recovery objective for the Mariana crow as the maintenance "... of at least 700 crows on Rota and to restore the Guam population to at least 700...." (Beck and Savidge 1990). A recent study of the status of the Mariana crow stressed the importance of having multiple populations and recommended that an additional crow population be established on another island (National Research Council 1997). Translocation of Mariana crows from Rota to Guam, as outlined in the recovery plan, is currently the best avenue to achieve the above objectives. Recently, the Mariana Crow Recovery Team, a committee organized to oversee the preservation and recovery of the species, endorsed the translocation of a limited number of crows from Rota to Guam.

Techniques required to successfully conduct a translocation project have been tried by the DAWR and proven satisfactory, including protection of nest trees from snakes and hand-rearing of crow chicks. The development of an effective electrical snake barrier to protect crow nests from snake predation resulted in five birds being fledging from wild nests between 1993 and 1995 (Aguon et al. 1998). In 1996, two crows were successfully hand-reared from eggs retrieved from protected nests and artificially incubated. These juveniles were hacked into the wild in 1997. Of these birds died 219 days after its release due to unknown causes, while the status of the second bird remains unknown.

Avicultural techniques were first applied to the species in 1996, when 9 crow eggs from 3 clutches were pulled from a single breeding pair in the MSA (DAWR 1996). After artificial incubation of the eggs, two chicks were successfully hatched, hand-reared, and released into the wild when they were 368 and 376 days old (DAWR 1997). Additionally, six adults crows captured on Rota in 1993 and sent to mainland zoos (National Zoo's Conservation and Research Center in Front Royal, Virginia and the Houston Zoo) were

transferred to back Guam and released in the wild in 1997. Two of the birds currently remain alive and are interacting with wild Guam crows, while the status of two others is unknown. A female and a male died 13 and 34 days, respectively, after their release. Causes of death are unknown, but necropsies found no evidence of snake predation. The decline of the population of crows on Guam will continue unabated without supplementation of birds from Rota.

OBJECTIVES

To develop and implement avicultural support program for the recovery of the Mariana crow as recommended in the Native Forest Bird Recovery Plan (Beck and Savidge 1990) and the National Research Council (1997) report.

PROCEDURES

1. Pull first and second clutches of eggs from nesting Guam Mariana crows after 7-10 days of incubation and artificially incubate. Handrear and release birds back into the wild after fledging in captivity, when they are at least 60 days old and are feeding independently.
2. Renew the endangered species subpermit from the U.S. Fish and Wildlife Service (USFWS) to take Mariana crows from Rota and hold them in captivity on Guam beyond 45 days. Renew the annual scientific collection permit from the Commonwealth of the Northern Marianas Islands (CNMI).
3. Collect up to 18 eggs and chicks from nesting crows and six adults on Rota. Coordinate between all agencies. Entire clutches of eggs, or broods of chicks will be collected.
4. Check each crow egg collected on Guam and Rota for gross cracks or breaks immediately upon collection. Weigh and candle eggs to determine the following: a) integrity, size, and location of air cell; b) integrity of yolk; c) presence or absence of hairline cracks or toenail punctures in the egg shell; and d) presence or absence of vascularization (indicating fertility and viability). Place eggs in an incubator and assess viability and weight loss every three days. Eggs showing no signs of embryonic development (i.e., progressive development of blood vessels) will be removed from the incubator. Brood and hand-rear chicks using The Peregrine Foundation guidelines developed for the alala (*Corvus hawaiiensis*), with appropriate modifications in diet and feeding regime to fit Mariana crow requirements.

RESULTS

No eggs were collected from Mariana crows on Guam. In November 1998, the DAWR received a USFWS endangered species permit and the CNMI scientific collecting permit to collect six adult crows and 18 chicks and/or eggs from Rota for translocation to Guam. However, because it was late in the breeding season, the DAWR was able to obtain only two chicks from Rota. In January 1999, a female chick about 27 days old and, in April 1999, a male chick about 17 days old were removed from their nests on Rota and hand-reared at the DAWR facility in Guam. The crows were instrumented with radio collars and released as juveniles in the MSA on 21 September 1999. The female died by asphyxiation (choked on native food items) on 23 September 1999, while the male was found dead of hepatitis two weeks after the release.

Based on weight comparisons among captive-reared Mariana crow chicks, males tended to be larger than females (Figure 1). Also, chicks that are captive parent-reared appear to be larger than hand-reared chicks. This suggests that cross fostering is preferred over handrearing. Unfortunately, with only a few breeding pairs left in the wild this is becoming less of an option. The two chicks hand-reared this season fledged at 45 days of age.

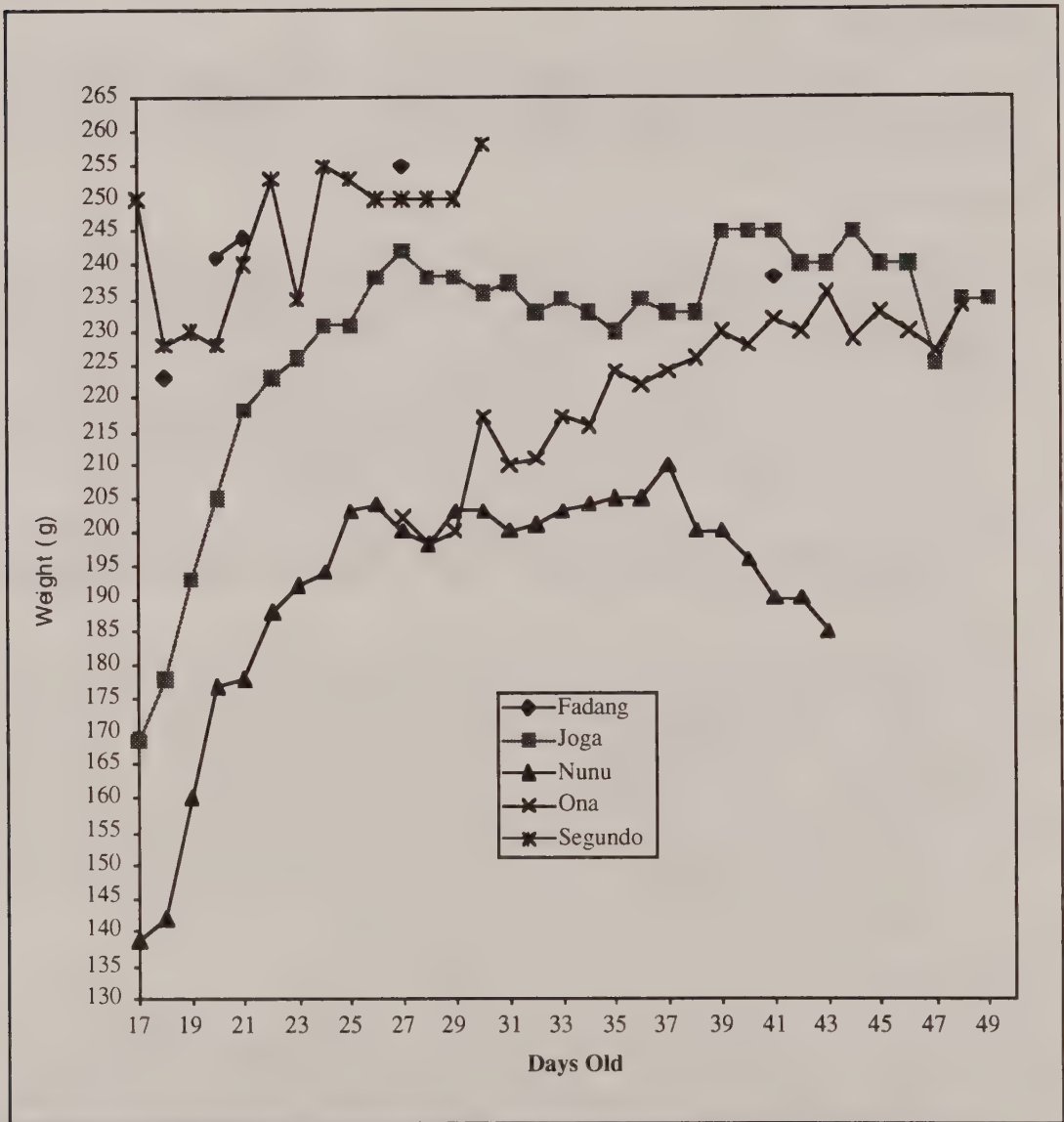


Figure 1. Growth curves for Mariana crow chicks hand-reared from artificially incubated eggs in 1996 (Joga and Nunu), wild hatched and translocated from Rota during the 1998-1999 breeding season (Una and Segundo), and a captive parent-reared chick from the Houston Zoo (Fadang). Males (Joga and Segundo) are larger than the females (Nunu and Una).

Behaviorally, raising chicks with a crow model appears to be important in reducing habituation to humans. Two birds hand-reared as solitaires, known as Una and Joga, were

more habituated to humans than birds hand-reared with a brood-mate or with a model. Birds reared with a live adult or broodmates were not easily approached. Future efforts should ensure that chicks are hand-reared with broodmates or raised with live adults when possible.

RECOMMENDATIONS

Continue avicultural intervention of Mariana crows and efforts to increase the production of crows in the wild through snake proofing of crow nest sites.

PROGRAM COSTS

The estimated cost of this project under E-2-2 is \$55, 000.

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Report prepared by: M. Kelly Brock, Celestino F. Aguon, and Suzanne Medina

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: B

JOB NO.: 3

JOB TITLE: Captive Propagation of Micronesian Kingfishers

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

DAWR biologist Kelly Brock continued to act as consultant for the Micronesian Kingfisher SSP. Conceptual plans were developed for a kingfisher captive breeding facility, and grant proposals were submitted to the MacArthur Foundation and Packard Foundation for construction funds. The MacArthur Foundation declined the proposal, but the Packard Foundation continues to be interested.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the Division of Aquatic and Wildlife Resources (DAWR), member zoos of the American Zoo and Aquarium Association, (AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program, when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984). The Micronesian kingfisher, *Halcyon c. cinnamomina*, was successfully brought into captivity (DAWR 1983-1986), with the capture of 31 wild birds that were immediately transferred to U.S. mainland zoos.

Kingfishers were first bred in 1985 at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo, and the Conservation and Research Center of the National Zoological Park). During FY '88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously unrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality, high young adult mortality, aggression, and infertility continue to limit population growth (Bahner 1993).

OBJECTIVES

1. Continue acting as field consultants to the Micronesian Kingfisher SSP.

2. Finalize construction plans for a kingfisher captive breeding facility.
3. Obtain a construction grant to build captive breeding facility.
4. Transfer 2.0 (males:females) or 1.1 kingfishers from mainland zoos to Guam to initiate captive breeding program on Guam.
5. Identify appropriate reintroduction sites for Micronesian kingfishers that meet criteria for snake control.
6. Recruit or train two additional staff to manage captive kingfishers on Guam.

RESULTS

In FY99, the living population of kingfishers increased to 64 birds. Seventeen kingfishers hatched in 4 of the 8 zoos housing the birds. Seven of those birds fledged, and only two adults died.

Gary Wiles and Kelly Brock conducted a survey for one of the kingfisher's preferred nesting trees, *Pisonia grandis*, in Area 50 as a prelude to identifying potential reintroduction sites for the species. A small clump of three living trees was found on Transect D near snake trap station eight. Area 50 will not be a suitable reintroduction site without extensive nestsite management (i.e., provision of artificial nest sites).

Kelly Brock met with Guam Department of Public Works engineers to sketch a conceptual plan for construction of a captive breeding facility for Micronesian kingfishers. A grant proposal for the construction costs was submitted to the MacArthur and Packard Foundations. The MacArthur Foundation declined the proposal, but the Packard Foundation expressed interest in seeing the proposal again as part of a block grant from a soon to be established Western Pacific consortium of colleges and natural resource agencies of Micronesia (MAREPAC, Inc.)

RECOMMENDATIONS

1. Continue acting as a consultant to the Micronesian Kingfisher SSP, coordinating all plans and activities with SSP Species Coordinator, Beth Bahner.
2. Meet with engineers to finalize construction plans for a captive breeding facility for kingfishers on Guam.
3. Pursue a Packard Foundation grant for construction of a facility.
4. Complete construction of facility by October 1, 2000.
5. Transfer 2.0 (males:females) or 1.1 Micronesian kingfishers from mainland zoos to Guam by December 2000.
6. Hire or train two staff for kingfisher management (husbandry and breeding).

PROJECT COST

The estimated cost of this project under E-2-2 is \$5,000.

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Report prepared by: M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: C

JOB NO.: 1

JOB TITLE: Establishment of an Experimental Population of Guam Rails on Rota or Other Islands in the Marianas

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

One hundred Guam rails (*Gallirallus owstoni*) were released at the Sagua'gagha area of Rota in February and August 1999. Twenty-two of the birds were released inside a 2.5-ha enclosure. Extensive efforts were made to remove predators from the release area, but none predators were trapped. Fifty-one birds were equipped with radio transmitters. Fourteen radio-marked rails were confirmed dead, with 5 of the deaths due to predation by feral cats. Nine radio-marked rails survived to the end of FY99. Eight of nine radio-marked birds escaped the enclosure within 10 days. Rails released in February survived an average of 103 days, with four birds living to the end of FY99 (237 days). Birds released in August survived an average of 29.9 days, with five living to the end of FY99 (63 days). Rails moved an average of 888 m from their release site (range 200-3,000 m). Reproduction was documented as 4 nests successfully hatched. Releases should continue with cohorts of 50 or more birds every 3-6 months until a self-sustaining population is established.

INTRODUCTION

Census data collected between 1960 and the early 1980s documented the reduction in range and numbers of the Guam rail (Witterman et al. 1990). In 1984, only about 20 rails were known to remain in the wild and the species was added on the U.S. Endangered Species List. In 1982, the DAWR decided to develop a captive breeding program for the Guam rail and by 1986, all known remaining rails were collected ($n = 21$). The extirpation of the Guam rail from the wild was due primarily to predation pressure from the introduced brown tree snake (*Boiga irregularis*). The captive propagation program was organized under the auspices of the American Zoo and Aquarium Association (AZA) and presently includes the cooperation of 14 mainland zoos. The rails demonstrated an immediate propensity for breeding in captivity and to date over 700 rails have been produced in captivity (Ondorff 1999).

The captive management of the Guam rail uses the metapopulation approach, which calls for the establishment of more than one subpopulation (Foose et al. 1986). This has been accomplished by dispersing the captive rails into two primary captive populations on Guam and in U.S. zoos. Because reintroduction of the Guam rail to part of its historical range on Guam is a recovery objective, the establishment of an experimental wild population on snake-free Rota was proposed (USFWS 1989), to serve as a third genetic reservoir to prevent genetic drift and inbreeding, and to ensure the maintenance of behavioral adaptations for the wild. Reintroductions of captive produced animals are less likely to succeed than translocations of wild-caught animals because of behavioral deficits (Griffith

in 1995. Experience gained in releasing Guam rails on Rota will provide valuable information and perhaps birds useful for future reintroductions.

OBJECTIVES

1. Establish a non-essential experimental wild population of the Guam rail in suitable areas free of predators on Rota (Commonwealth of the Northern Mariana Islands (CNMI)).
2. Release up to 1% captive-produced rails per year from the propagation facility of the Division of Aquatic and Wildlife Resources (DAWR) to initiate establishment of rails on Rota.
3. Release captive-produced rails from the propagation facilities of cooperative mainland zoos to initiate establishment of rails on Rota.
4. Monitor survival, dispersal, reproduction and establishment of released rails through radio telemetry.

PROJECT HISTORY

In 1977, a cooperation agreement was signed between the Government of Guam, CNMI, and the U. S. Fish and Wildlife Service (USFWS) outlining the responsibilities of each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the Guam rail to Rota. The DAWR reached an informal agreement with Dr. Stuart Pimm, University of Tennessee, by which a graduate student resided on Rota to monitor the initial two rail introductions in cooperation with the DAWR as a part of his dissertation research. Dr. Pimm was successful in receiving several grants from international conservation organizations to support efforts to monitor the introductions on Rota.

After a permit to establish an "experimental population" of Guam rails on Rota was published (USFWS 1989), 22 rails were released at a site on the Sabana on Rota in December 1989 and January 1990. All but one rail were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. The site proved to be unsatisfactory probably due to the presence of dense grassland habitat. Of the 22 released birds, the whereabouts of 9 were unknown as their radios failed, 4 were killed by vehicles, 2 were killed by cats, 2 apparently died of starvation, 1 died of poisoning, and 4 died of unknown causes (Wittman et. al. 1990, DAWR 1991).

In February 1991, 33 rails were released at the forest edge in I Chenchon Park near the Bird Sanctuary overlook (Wittman and Beck 1991). This release appeared to be more successful than previous ones. Releases were discontinued until the spring of 1995 due to the low production of rails at captive breeding facilities.

Beginning in 1995, the release site was moved further inside the forest to the east from the 1991 release site. So far, 267 rails have been released on Rota: 21 in December 1989, 33 in February 1991, 15 in March 1995, 30 in August 1995, 15 in September 1995, 15 in April 1996, 19 in April 1997, 19 in June 1998, 50 in February 1999, and 50 in August 1999 (DAWR 1995-1998).

METHODS

Study Site Description

The release area is a coastal limestone cliff area located on the eastern end of the island on a narrow shelf of native limestone forest bound by upper and lower limestone cliffs. South of the shelf and bordering the ocean is a large seabird nesting colony. The remaining area is a mixture of native forest pockets, scrub (secondary growth), and clearings with coconut plantings.

Release Method

Guam rails arrived on Rota via commercial airplane. Fifty rails (25 males, 25 females) were released between 9-12 February 1999 and 50 more (25 males, 25 females) were released between 4-6 August 1999. All birds had serially numbered aluminum bands on the right leg. Twenty-seven of the 100 birds were placed inside a temporary 2.5 ha enclosure that was constructed at the eastern end of the former release area that was built before the June 1998 release. The enclosure is constructed of 6' x 1" chicken wire and is tacked to trees in the forest using staples, wire, and plastic ties.

Predator Control

As many as 17 live traps were set along the trail in the release area to control feral cat (*Felis domesticus*) and monitor lizard (*Varanus indicus*) populations. Cat traps were placed 100-200 m apart along the trail for a distance of about 2 km. Canned cat food was used as bait. Traps were set for capture all day as monitor lizards were also targeted for capture. Following capture of a cat or monitor lizard, the animal was killed with a pellet gun, weighed, measured, classified to age and sex, and its gut contents checked for remains of rails.

Radiotelemetry

Fifty-one birds (26 in February, 25 in August) were equipped with backpack mounted radio transmitters (Holohil Systems Ltd.). Radio-marked birds were relocated using a Telonics TR-2 portable receiver/scanner and a hand-held antenna. Locations of radio-marked rails were recorded according to the station (every 25 m along the main trail) to which they were the closest. If rails dispersed out of the release area and away from the trail, general topographical and geological features were used to describe the bird's location. Birds were periodically flushed to determine if nests or broods were present. Data was collected on survivorship, mortality, and dispersal. Extensive ground searches were made to locate birds that dispersed and whose radio signals could not be found in the release area.

Supplemental Feeding

Supplemental food stations were set up inside the enclosures and in the release area in an attempt to get the rails to stay in the release area. The food (captive diet) was presented in the same manner on Rota as it was in captivity on Guam. Every morning, fresh food was put in a plastic dish under a tent of aluminum and wood to protect it from rain. Once it was determined that a station was being used, a temporary blind was placed near the station to visually monitor the birds. Feeding and mating behaviors were recorded.

RESULTS

Predator Control

No cats or monitor lizards were trapped during 796 trap nights this fiscal year (Table 1).

Table 1. Predator trapping results at the rail release area on Rota, 1995-1999.

Year	trap nights	monitor lizards		feral cats	
		Total No. caught	Cature rate per 1,000 trap nights	No. caught	per 1,000 trap nights
1995	1,322	5	3.78	9	6.81
1996	3,218	9	2.80	10	3.12
1997	1,498	2	1.34	4	2.67
1998	1,858	1	0.54	9	4.84
1999	796	0	0.00	0	0.00
Total	8,692	17	1.96	32	3.68

Mortality, Survival, and Movements

Based on radio-marked birds with known fates (n=23, either counted as alive or dead at the end of the reporting period), mortality was 61% and survivorship was 39% (Table 2). Assuming the mortality rate of non-radio-marked birds was the same as radio-marked birds, an estimated 39 birds are still surviving as of 30 September 1999. If birds with unknown fates were considered alive at the end of the reporting period, the number of birds alive would significantly increase to 74. If birds whose fates were unknown were considered dead at the end of the reporting period, the number alive would be as few as 18 (see Table 2).

Five of the 14 deaths were due to cat predation, while 6 birds died of unknown causes. One bird died when it was trapped in a cat trap for several days, and two were run over by vehicles. Of the 28 radio-marked birds with unknown fates, 9 birds had mortality signals turn on but the transmitters were not recovered, 3 birds dropped their transmitters, 3 radios failed prematurely, and contact was lost with 13 birds (Table 2).

Table 2. Fates of 51 radio-marked rails released on Rota in 1999.

	Dead	Radio Failure	Mortality Signal	Lost Signal	Dropped Transmitter	Alive
February	6	3	4	6	3	4
August	8	0	5	7	0	5
Totals	14	3	9	13	3	9

Rails released in February lived an average of 103 days (237-day reporting period, range = 3 – 237) and moved a mean of 908 m from the release site (range = 200–2,300 m). Birds released in August lived an average of 29.9 days (63-day reporting period, range = 4 – 63) and moved an average of 867 m from the release site (range 200-3,000 m) (Tables 3, 4). Nine birds (four from February, five from August) lived to the end of the reporting period.

Eight of nine radio-marked birds escaped the enclosure within 10 days during the reporting period. Only one bird stayed in the enclosure longer than 10 days (52 days), but it died inside the enclosure. Rails that escaped from the enclosure moved a mean distance of 850 m away from the release site, with the longest documented distance being 2.0 km.

Table 3. Radio-marked rails released on Rota, February 1999.

Band #	Frequency	Sex	Age (Yrs)	Release Weight (Grams)	Date Released	Date Recovered	# Days to Status	Distance from Release Site (Meters)	Fate
2015	164.011	F	1	233	Feb 9	Aug 26	198	1200	Dead. Crushed by truck.
2066	164.064	M	1	241	Feb 9	Feb 9	—	—	Radio failure.
651	164.247	F	2	253	Feb 9	Oct 4	237	1300	Mortality signal. Not recovered.
656	164.316	F	2	209	Feb 9	Feb 12	3	300	Mortality signal. Not recovered.
2016	164.471	F	1	278	Feb 9	Mar 12	31	1100	Lost signal.
2032	164.649	M	1	300	Feb 9	Feb 19	10	600	Lost signal.
2000	164.709	M	1	224	Feb 9	Sep 30	233	1700	Alive as of 9/30/99.
649	164.920	M	2	291	Feb 9	Mar 12	31	300	Dropped transmitter.
2038	164.202	M	1	292	Feb 10	Oct 4	236	1300	Mortality signal. Not recovered.
2048	164.502	F	1	182	Feb 10	Aug 20	191	1000	Radio failure.
2002	164.596	M	1	262	Feb 10	Feb 17	7	400	Lost signal.
664	164.740	F	2	322	Feb 10	Mar 12	30	300	Dropped transmitter.
679	164.750	M	1	242	Feb 10	Sep 27	229	1000	Radio failure.
2050	164.870	M	1	237	Feb 10	Jun 29	139	200	Lost signal.
2033	164.959	F	1	192	Feb 10	Feb 14	4	300	Dead.
2057	164.988	F	1	243	Feb 10	Feb 18	8	1400	Mortality signal. Not recovered.
681	164.144	F	1	220	Feb 11	Mar 14	92	400	Lost signal.
2058	164.237	F	1	190	Feb 11	Apr 5	53	500	Dead.
2017	164.570	M	1	250	Feb 11	Feb 23	12	1900	Dead.
2052	164.610	F	1	210	Feb 11	Feb 24	13	2300	Dead.
2028	164.658	M	1	250	Feb 11	May 25	103	1200	Lost signal.
2047	164.177	M	1	235	Feb 12	Oct 6	236	1200	Alive as of 9/30/99.
2030	164.305	F	1	270	Feb 12	Feb 16	4	300	Dead.
2060	164.640	M	1	217	Feb 12	Feb 16	4	1000	Dropped transmitter.
2037	164.669	F	1	250	Feb 12	Oct 6	236	200	Alive as of 9/30/99.
2027	164.730	M	1	245	Feb 12	Oct 6	236	1300	Alive as of 9/30/99.

Table 4. Radio-marked rails released on Rota, August 1999.

Band #	Frequency	Sex	Age (Yrs)	Release Weight (Grams)	Date Released	Date Recovered	# Days to Status	Distance from Release Site (Meters)	Fate
2043	164.114	F	1	245	Aug 4	Oct 6	63	1200	Alive as of 9/30/99.
2055	164.254	F	1	250	Aug 4	Oct 6	63	1200	Alive as of 9/30/99.
2094	164.266	F	<1	215	Aug 4	Aug 9	5	200	Dead.
2093	164.421	F	<1	265	Aug 4	Aug 27	23	300	Mortality signal. Not recovered.
2085	164.435	M	1	250	Aug 4	Aug 12	8	300	Dead.
947	164.490	M	3	280	Aug 4	Sep 24	51	1300	Mortality signal. Not recovered.
613	164.550	M	3	270	Aug 4	Aug 12	8	600	Dead.
2090	164.776	F	1	195	Aug 4	Aug 26	22	800	Dead.
2077	164.820	M	1	255	Aug 4	Oct 6	63	600	Alive as of 9/30/99.
2039	164.840	M	1	265	Aug 4	Aug 25	21	600	Lost signal.
2084	164.850	F	1	200	Aug 4	Aug 19	15	600	Lost signal.
661	164.024	M	2	290	Aug 5	Aug 18	13	300	Lost signal.
2087	164.087	F	1	225	Aug 5	Aug 9	4	200	Dead.
110	164.093	M	1	265	Aug 5	Sep 13	39	1200	Lost signal.
2022	164.152	M	1	225	Aug 5	Oct 6	62	1700	Alive as of 9/30/99.
2081	164.323	M	1	250	Aug 5	Sep 1	27	3000	Mortality signal. Not recovered.
2012	164.333	M	1	295	Aug 5	Oct 6	62	1400	Alive as of 9/30/99.
2075	164.344	F	1	225	Aug 5	Aug 31	26	1500	Mortality signal. Not recovered.
2091	164.513	M	<1	250	Aug 5	Aug 26	21	900	Lost signal.
2083	164.535	F	1	240	Aug 5	Aug 12	7	475	Lost signal.
337	164.969	F	1	225	Aug 5	Aug 10	5	400	Dead.
2062	164.104	F	1	220	Aug 6	Aug 21	15	300	Dead.
2064	164.279	F	1	235	Aug 6	Sep 27	52	100	Mortality signal.
2078	164.806	F	1	280	Aug 6	Aug 23	17	500	Lost signal.
699	164.898	M	1	275	Aug 6	Sep 30	55	2000	Dead.

Reproduction

Five nests were documented during FY99 (Table 5). Average clutch size was 3.4 eggs (range 2 – 5). Birds released in February produced four nests, with nine of the 15 eggs hatching. One nest was found with two eggs that were laid by a female from the August release. This nest was still unhatched at the end of the reporting period. Nests were built an average of 1,280 m from the release site, all to the west-southwest. Nests tended to be in open areas of grasses and shrubs surrounded by secondary growth forest. In addition to documented nests, two juvenile rails were seen with a radio-marked adult male in the limestone forest below the Bird Sanctuary overlook, and chicks were heard with male 164.178 prior to the discovery of what appeared to have been a subsequent nest (Table 5).

Table 5. Nesting of Guam rails on Rota, 1999. Each of the radio-marked birds listed below paired and nested with non-radio-marked birds or birds whose radios slipped or malfunctioned.

Radio Frequency (Mhz)	Sex	Date Found	Date Hatched	# Eggs	# Hatched	Distance from Release Site (m)
164.011	F	6 Jul	14 Jul	4	3	1,200
		13 Aug ^a	23 Aug	5	2	1,200
164.709	M	27 Jul	11 Aug	3	3	1,700
164.178	M	23 Aug	27 Aug	3	1	1,100
164.114	F	27 Sep	—	2	—	1,200

^aSecond nest of female 164.01

DISCUSSION

Although no cats were trapped this fiscal year, 5 of the 14 rail deaths (36%) were attributed to cat predation. All of these deaths occurred down in the seabird colony, where daily cat trapping was logistically difficult. On one occasion, a large male cat was seen near the site of a rail kill. The decrease in capture rate and the high number of deaths contributed to feral cat predation in 1999 is an indication that trapping has been locally effective around the release site, but that an expanded effort is needed in the seabird colony where rails are dispersing. It is advisable to increase the cat trapping effort by either increasing the number of traps or by actively hunting cats at night, or both, and periodically relocating traps in order to minimize the chances that cats habituate to their location.

Although no monitor lizards were trapped during FY99, they are still a potential predator of adult rails, chicks, and eggs. Continuing to trap and remove monitor lizards from the area is advisable.

No aerial surveys were conducted this year to find lost birds. However, as 13 signals were lost, it is advisable to continue aerial surveys to locate those birds that have dispersed from the release area or are in areas inaccessible on foot.

The 2.5-ha corral in the release area was again not successful in reducing rail dispersal, as only one bird stayed in the pen longer than 10 days (52 days). If the pen is to be effective in keeping the rails from dispersing, the fence needs to be separated from the vegetation of the forest on the inside of the pen by 2-3 m. This will make it difficult for rails to escape by climbing the vegetation and jumping over the fence. Unfortunately, this option requires too much habitat modification to be considered a preferred method.

The nesting success documented in 1995 and 1999, when 45-50 birds were released together, indicates that releases of large cohorts of Guam rails is key in overcoming

dispersal and mortality, regardless of release method. No nesting was documented for any individuals released in smaller groups, either within or outside of the corral.

CURRENT STATUS OF PROGRAM

Guam rails continued to be monitored on Rota by Stan Taisacan, formerly of the CNMI, Division of Fish and Wildlife. Mr. Taisacan is contracted by DAWR to assist with monitoring rails. Releases of at least 50 Guam rails per group will continue into FY00.

RECOMMENDATIONS

1. Continue to trap and remove feral cats and monitor lizards from Sagua'gahga forest and surrounding areas.
2. Improve the enclosure to reduce the escape rate of rails.
3. Investigate the possibility of changing the release site or releasing some rails at the Bird Sanctuary parking area, where at least 5 pairs have established territories. Increase release cohorts to 50 birds minimum every 3-6 months until the birds become established. Resume periodic aerial surveys to find radio-marked birds that may have dispersed from the release area.
4. Continue the use of supplemental feeding stations as this may help to reduce dispersal and facilitates observation of birds.

ACKNOWLEDGEMENTS

The USFWS and DFW staff on Rota were extremely helpful in supplying manpower and vehicles, and assisting with the transportation of rails and equipment into the forest. Stan Taisacan was contracted to assist with monitoring the movements, survival, and reproduction of rails after DAWR staff and volunteers returned to Guam. The Cincinnati Zoo sponsored Guam rail keeper Chris Edelen to participate in the February 1999 release. Chris assisted with predator control, and monitoring movements and survival of rails.

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Report prepared by: Grant M. Beauprez and M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-2-2

SUB-PROJECT: D

JOB NO.: 1

JOB TITLE: Establishment of Populations of Endangered Species in Snake-Free Areas

PERIOD COVERED: October 1, 1998 to September 30, 1999

SUMMARY

Sixteen Guam rails (*Gallirallus owstoni*) (8 males, 8 females) were released in Area 50 on 16 November 1998. Rails survived an average of 198 days, although 5 (31%) rails were still known to be alive at the end of the reporting period (318 days). Seven birds (44%) were found dead, 2 birds had their radios fail before the end of the fiscal year, while 2 birds dropped their radios. A total of 4 females and 5 males nested during the reporting period producing 17 nests (mean clutch size of 2.94 eggs, range = 1-4) and successfully hatching 42 of 50 eggs (84%). Birds were capable of recycling quickly as the average time between the hatching of successive nests for any particular bird was 55.5 days (range = 27-112 days). A total of 512 trap nights (TN) were completed for the fiscal year, capturing 8 feral cats (1.56 cats/100TN) and 5 monitor lizards (0.98 monitors/100TN). A mark-recapture study should be initiated to get a population estimate and survivorship data on rails hatched in Area 50, and to gain additional information on movements, reproduction, and habitat use.

INTRODUCTION

Census data collected between 1960 and the early 1980s documented the reduction in range and numbers of the Guam rail (Witteman et al. 1990). The extirpation of the Guam rail from the wild was due primarily to predation by the introduced brown tree snake (*Boiga irregularis*) (Savidge 1987). In 1984, the rail was added to the U.S. Endangered Species List when only about 20 individuals were known to remain in the wild. In 1982, Guam's Division of Aquatic and Wildlife Resources (DAWR) developed a captive breeding program for the rail and collected all known remaining rails from the wild (n=21) by 1986. The rails have reproduced well in captivity and currently number about 140-150 birds distributed between Guam and 14 mainland zoos.

From 1989-1999, 267 Guam rails were released on Rota, Commonwealth of the Northern Mariana Islands (CNMI) for the purpose of establishing an experimental wild population in a snake-free environment (Beauprez and Brock 1999). In 1995 and 1999, reproduction was documented among the rails translocated from captivity to the wild on Rota, suggesting that the technical aspects of introduction were achievable.

Current brown tree snake control methods include the reduction or eradication of snakes from large-scale areas using trapping and exclosure barriers (Brock et al., in prep.). Area 50 is a 24-ha plot of mixed forest in Northwest Field on Anderson Air Force Base, Guam (Figure 1). It is surrounded by old runway tarmacs and enclosed by a 2-m tall chain link fence. It has been set aside for the purpose of environmental recovery activities to include

the removal of brown tree snakes, feral pigs (*Sus scrofa*), and deer (*Cervus mariannus*),



Figure 1. Location of Area 50 in Northwest Field, Guam.

and the recovery of several native species including the Guam rail, Mariana crow (*Corvus kubaryi*), Micronesian kingfisher (*Halcyon cinnamomina*), and the tree *Serianthes nelsonii*.

OBJECTIVES

1. Establish a wild population of Guam rails in snake-free habitat in northern Guam.
2. Monitor survival, dispersal, reproduction, and establishment of released rails through radio telemetry.
3. Use rails born in Area 50 as stock for introductions of birds to other snake-free areas on Guam.

METHODS

Sixteen Guam rails (8 males, 8 females) were released in Area 50 on 16 November 1998. All birds were equipped with backpack mounted radio-transmitters (Holohil, Inc., Ontario, Canada). A serially numbered aluminum band was placed on the right leg of all birds and a red band placed on the left leg of the males. Birds were tracked using a precision direction finding antenna array (Telonics, Inc., Mesa, Arizona) or hand-held antennae (Conway et al. 1993, Shivik et al. 1996).

The removal of brown tree snakes from the perimeter of Area 50 continued during the study. Trapping methodologies follow those in Brock et al. (1999). As many as 10 traps were used to capture feral cats from inside and surrounding Area 50 prior to and throughout the study.

RESULTS

Predator Control

A total of 512 trap nights were completed in Area 50 during FY99, capturing 8 feral cats (1.56 cats/100 trap nights) and 5 monitor lizards (0.98 monitors/100 trap nights). All predators were captured outside the fence of Area 50, although cat scat was seen inside the fence on several occasions.

Survival

Rails survived an average of 198 days, with five (31%) birds still known to be alive at the end of the reporting period (range = 0-318 days) (Table 1). Seven (44%) birds were found dead, two had their radios fail before the end of the fiscal year, and two birds dropped their radios.

Movements

Rails initially made large movements during the first 1-2 weeks after being released until they found a mate and settled into territories. Birds seemed to concentrate in the four-corners of the area, with few movements across the interior. Home ranges seemed to cover 1-2 ha, although specific values had not yet been calculated at the end of the reporting period. It appears that males may range farther than females, particularly when females are on a nest, but these data have not yet been analyzed.

Table 1. Fates of 16 Guam rails released in Area 50, November 16, 1998.

Frequency	Band #	Sex	Age at Release	Weight (Grams)	# Days to Status*	Fate
164.066	2007	M	5 mos	245	7	Dead, failure to forage
164.126	10301	F	7 yrs	280	318+	Alive
164.197	617	F	2 yrs	280	206	Dead, cause unknown
164.211(883)**	696	M	6 mos	235	318+	Alive
164.287	692	F	6 mos	205	85	Dead, caught in vegetation
164.356	695	M	6 mos	255	273+	Radio Failure
164.378	2001	F	5 mos	215	203+	Dropped Transmitter
164.406	693	F	6 mos	205	318+	Alive
164.481	622	M	2 yrs	255	318+	Alive
164.588(104)**	10302	F	7 yrs	255	318+	Alive
164.629	2006	F	5 mos	240	84	Dead, caught in vegetation
164.702	680	F	11 mos	225	128	Dead, cause unknown
164.760	694	M	6 mos	270	0+	Radio Failure
164.862(287)**	2008	M	5 mos	240	260+	Dropped Transmitter
164.888	697	M	6 mos	220	103	Dead, cause unknown
164.932	618	M	2 yrs	245	226	Dead, tangled in vegetation

*Birds with a (+) next to their "# Days to Status" indicates that the bird is, or could still be alive, and may have lived longer than the number indicated.

**Frequency in parentheses represents a replacement transmitter.

Reproduction

Four females and five males nested during FY99, producing 17 nests (mean clutch size = 2.94 eggs, range = 1-4) and successfully hatching 42 of 50 eggs (84%) (Table 2).

Birds were capable of recycling quickly as the average time between the hatching of successive nests for any particular bird was 55.5 days (range = 27-112 days). The first nest was found on January 14, 59 days post-release. Females displayed nest site fidelity as nests were often within 10-20 m of their previous nest, with the exception of female .196 whose nest with her second mate was about 300 m north of her previous nest sites.

Table 2. Nesting of Guam rails in Area 50, 1999.

Freq(F/M)	# Nests	# Eggs	# Hatched
.377/.355	2	6	6
.196/.888-.861*	3	8	4
.587/.211	5	15	14
.126/.481	7	21	18
Totals	17	50	42
Average	4.3	12.5	10.5

*Female .196 first nested twice with male .888 until he died, then nested with male .861.

DISCUSSION

When Guam rails were initially released into Area 50, when birds were seen pacing along the edge of the fence on several occasions, as if they were still confined in their holding cages at the DAWR breeding facility. It was this sort of behavior that led to the death of

one bird seven days after its release, suggesting the bird never adapted to the wild. However, after several weeks, most birds seemed to settle down and establish territories. The perimeter fence was successful in controlling the dispersal of the rails, as no birds were known to have escaped during the study. This facilitated the pairing up of rails and the establishment of territories. Most birds appeared to settle within 100 m of the fence, mostly in the south, west, and east corners, in areas of secondary forest and low scrubby vegetation. Snake capture rates remained at maintenance levels (0.0 – 0.5 captures/100 trap nights) throughout the study and no mortality of rails or eggs was attributed to snake predation.

The capture rate for feral cats outside of Area 50 was quite high (1.56 cats/100 trap nights) compared to the overall rate for Rota (0.37 cats/100 trap nights) (Beauprez and Brock 1999). Cats captured on Guam were larger than on Rota (avg = 3,375 g on Guam, avg = 2,270 g on Rota). It was reported that Air Force personnel living at the nearby Detachment 5 facility had been feeding a number of feral cats. This may explain the high capture rate at Area 50, as well as the relative health of the cats. It is advisable to continue trapping cats in and around Area 50 to prevent future predation on introduced rails.

Rails made large movements following their release until they found a mate and settled into territories. Birds seemed to concentrate mostly in the south and west corners, and they could often be heard calling during the early morning and evening hours. Home ranges seemed to cover 1-2 ha, but this may vary depending on whether the bird was solitary or paired. Pairs seemed to be more sedentary than unpaired birds, and males appeared to range farther than females. A complete analysis of telemetry and movement data should to be completed to determine the home ranges of individual birds, pairs, and broods.

Males may play a critical role in nesting and brood rearing. Although females were most often found on nests during the daylight hours, males were periodically found incubating during daylight hours as well. Males also seemed to incubate more often at night. Additionally, since the turnover rate between successive nests was quick (avg = 55.5 days), males may play a more important role in rearing the brood and only a minor role in the actual incubation, as the female may often be incubating a nest while the male is taking care of the offspring. A more thorough study of the reproductive biology and behavior of Guam rails should be initiated.

Rail reproduction in Area 50 was excellent, with 42 chicks produced from 9 captive-reared birds. However, the survival rate of chicks is unknown. Chicks were heard in the vicinity of their radio-marked parents on numerous occasions, but were rarely seen. On one occasion, a pair of juvenile rails was captured in a cat trap, but one of them was killed when the trap door came down on its neck. The surviving chick was old enough to be banded, but was too small for a radio transmitter and was released. Many of the chicks produced at the beginning of the year would now be of reproductive age and could be producing offspring of their own inside Area 50. A mark-recapture study should be initiated to estimate the number of rails in the area. This would allow wild-born birds to be banded and radio-marked, and provide information on their movements, reproduction, and habitat use.

RECOMMENDATIONS

1. Continue trapping and removal of feral cats from in and around Area 50.
2. Continue to perimeter trap for snakes around Area 50 to reduce the threat of predation.

3. Continue to monitor rails via radiotracking to obtain data on movements, reproduction, and habitat use.
4. Implement a mark-recapture study to gain a population estimate for rails in Area 50, and data on survivorship of rails hatched in Area 50.

PROJECT COST

The estimated cost of this project under E-2-2 is \$50,000.

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